INOPHYTE'S 2-METER CONVERTOR
Easy-to-build accessory tunes hams, MARS, CD nets on any BCB set

How Electronics Outsees the Telescope

Science Fair Extra
WINDY the WHIRLER
Ingenious wind-speed indicator puts you one up on the weatherman

DUO-LITE Q-CHECKER
Two lights keep you out of the dark by revealing a transistor's all

Beginning an all-new series: FAMOUS MEN OF SCIENCE
Dazzle your friends with lightworks.

Sound n' Color®
The new dimension to music pleasure.
EICO All Electronic Solid-State Audio-Color Drivers transform sound waves into moving, synchronized color images. Connect easily to stereo leads of hi-fi or radio. From $29.95

Translators
The electronics you need to create audio-stimulated light displays to your own imagination. Accessories. Light Display Units. Strobe Lites only, both in configurations. (Xmas trees, paddy lights, etc.) From $24.95 kit. $37.95 wired.

Strobe Lites
High-intensity bursts of white light from Xenon tube flash in alliance with earth beat of audio from $34.95 to $53.95 each.

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CIVIL ENGINEERING
Construction Engineering Construction Engineering Construction Engineering

CIVIL ENGINEERING
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SPECIAL CONSTRUCTION PROJECTS

Treasure Witcher—dig where the headphones buzz, and buried treasure might well be yours

Duo-Lite Q-Checker—easy-to-build unit tells whether transistors are open, shorted, or leaky; npn or pnp; even measures beta!

SPECIAL SCIENCE FAIR PROJECT

“Windy” the Wind Gauge—our anemometer accurately clocks wind speeds from a dead calm to a killer hurricane

INTRODUCING OUR NEW DEPARTMENT

Great Men of Science—Lord Kelvin, alias William Thomson, a great physicist and engineer (1824-1907)

SCIENCE FEATURE SPECIALS

Down Under a Mile and a Half High—electronics in the world’s newest—and highest—subway system

Famous Patents—Alexander Graham Bell’s Photophone

Bird Watchers Worth Watching—homing in on the bionics of a pigeon in flight

ASTRONOMY

The Skies Above Us—the stars and our calendar

New Age of Astronomy—how sophisticated electronics outdoes optics in man’s never-ending quest to learn more of the heavens

S/E LABORATORY CHECK

Fisher Model 500-TX AM/FM-Stereo Receiver

COMMUNICATIONS CONSTRUCTION PROJECTS

Doubletimer—instant time zones on your wrist

SemiPro—sure-fire converter feeds 2-Meter signals to your BCB receiver

Station Blazer—broad-band preamp puts zonk into any SW set

COMMUNICATIONS FEATURES

How to Get Started in Radio—cartoon page

Ham Traffic—who’s minding the store?

Horace Twipple Brought Back Radio—funny fiction

DEPARTMENTS

Bookmark—by Bookworm

Stamp Shack—philatronics

New Products—showcase for shoppers

Ask Me Another—readers’ Q & A

Literature Library—keep the mailman busy

White’s Radio Log, Volume 52, Part 2—page 81

Emergency Radio Service—Southern California—page 95
The New 1970 Improved Model 257  
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TUBE TESTING OUTFIT

- Tests all modern tubes including Novars, Nuvistors, Compactrons and Decals.
- All Picture Tubes, Black and White and Color

ANNOUNCING... for the first time

A complete TV Tube Testing Outfit designed specifically to test all TV tubes, color as well as standard. Don't confuse the Model 257 picture tube accessory components with mass produced "picture tube adapters" designed to work in conjunction with all competitive tube testers. The basic Model 257 circuit was modified to work compatibly with our picture tube accessories and those components are not sold by us to be used with other competitive tube testers or even tube testers previously produced by us. They were custom designed and produced to work specifically in conjunction with the Model 257.

The Model 257 is housed in a handsome, sturdy, portable case. Comes complete with all adapters and accessories, ready to plug in and use. No "extras" to buy. Only $52.50

NOTICE

We have been producing radio, TV and electronic test equipment since 1935, which means we were making Tube Testers at a time when there were relatively few tubes on the market, way before the advent of TV. The Model 257 employs every design improvement and every technique we have learned over an uninterrupted production period of 34 years.

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SEND NO MONEY WITH ORDER
PAY POSTMAN NOTHING ON DELIVERY
Pay Cash or in EASY MONTHLY PAYMENTS AFTER 15 Day Trial!

Try it for 15 days before you buy. If completely satisfied remit $52.50 plus postage and handling charge. (If you prefer you may PAY MONTHLY ON OUR EASY PAYMENT PLAN.) If not completely satisfied, return to us, no explanation necessary.

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Please rush me one Model 257. If not satisfactory I agree to pay at the terms specified at left. If not satisfactory, I may return for cancellation of account.

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APRIL/MAY 1970
Points the Way. Here, in one single volume, is the most important and useful tool you find for working with electronic meters—Handbook of Electronic Meters: Theory and Application by John D. Lenk. Designed for electronics engineers and technicians, it provides not only the "how-to" of a great variety of electronic test procedures, but offers detailed, easy-to-follow explanations of the reasoning behind each test. If your professional range includes the use of any type of electronic meter, this is a handbook you cannot afford to be without.

Detailing the greatest number of meter applications available in a single handbook, this manual covers a full range of practical solid-state and integrated circuit data. It spans the entire subject, beginning with simplified presentations of operating principles and characteristics of typical laboratory and shop meters and accessory equipment. The descriptions include test connection diagrams for each operation and are all illustrated in block diagram or simplified schematic level, thereby offering an ideal source of easily accessible facts on meter theory and application. A valuable feature of this handbook is the self-contained aspects of each meter procedure and application, thus eliminating any need for cross-checking data elsewhere in the book. And since every practical, experience-proven application for modern meters is included, this handbook represents not only the most complete one available, but virtually the only one you will need to master the full range of basic modern electronic meter theory.
most modern, solid-state equipment—the equipment being used today. Its up-to-date information and broad, detailed coverage make it a "must" for anyone concerned with the vital, changing field of television today. No special technical knowledge is necessary to understand the clear, readable text. The author has chosen to by-pass complex mathematical formulas so that readers with a basic grasp of electronic and transistor theory will find the material readily comprehensible.

Principles and operation of television equipment of all types, used in both broadcast and closed circuit systems, are covered. Separate chapters are devoted to monochrome and color equipment. Various kinds of generation equipment, monitors, and receivers are discussed clearly and in depth.

The book begins with a consideration of the wide and varied uses of television today. An overview of the types of television equipment is followed by separate chapters devoted to in-depth examinations of the principles behind each type, as well as their operation. Among the many major topics: Principles of Optics; Scanning Systems: Video Amplification and Processing; Monochrome Television Monitors; Principles of Color Television; The Color Camera and Associated Circuits; Sync Lock Circuitry and Subcarrier Generators; Glossary of Television Terms.

Several photographs and detailed diagrams of the latest transistorized circuits accompany the highly readable text. Questions and simple problems covering important points in each chapter appear at the end of the text, as aids

The author is no stranger to his magazine. His many articles in the past have been well received. To get your copy of this text, stop by your local bookstore or write to the publisher—Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632.
to comprehension. Available at bookstores or direct from the publisher, Prentice-Hall, Inc., Englewood Cliffs, N.J. 07632.

**Calling all CBers.** Here is an all-in-one book on Citizens Band radio, and how to make the best use of available equipment. Tabbed the *CB Radio Operator's Guide*, this text is authored by Bob Brown (he writes for this magazine) and Paul Lawrence. Now, a CB Radio user's “bible”, the first really complete “how-to” book on Citizens Band two-way radio communications, tells you everything you want to know—and must know—to get on the air, from a description of what it is to what can, and can’t be, done right down to the “nitty gritty” rules and regulations. What’s more, the book contains expert advice on the type of equipment to buy, and how to get the best performance out of the “system.”

The reader will learn about antenna systems, including how they are used in CB and the various types to use for specific applications such as for base and mobile installations (including a directory of suppliers). And to keep him operating to the letter of the law, there’s a Chapter containing the complete FCC rules and regulations (as well as Canadian rules). A truly useful handbook for anyone interested in the subject. You can get your copy direct from the publisher—Tab Books, Blue Ridge Summit, Pa. 17214.

- The latest of “communications” stamps come from the Netherlands Antilles, which issued a pair on Feb. 5, to commemorate the fifth anniversary of *Trans World Radio-Bonaire*. The 10-cent, which is for use on postcards mailed within the six islands of the Carribean nation, features a picture of the studio-office complex in Bonaire and one of 30 antennas used to transmit its signals. The 15-cent denomination, for foreign postcards and domestic first class letters, is purely symbolical in concept. Created by Curacao artist Charles S. Corsen, the design comprises a cross encircled by two rings representing radio waves, set against a background of land, sea and sky. Both are printed in yellow, red, blue and black.

*Trans World Radio* is one of the more unusual of the world’s networks. Back in 1952, Dr. Paul E. Freed, a successful evangelist, conceived TWR as a non-profit, interdenominational medium to reach a much larger audience for his faith ministry. He was working in Morocco at the time, and with funds he solicited from persons interested in his work, he opened a small radio facility which he originally called *The Voice of Tangier*.

- Gradually he built up an audience that listened to his gospel messages quite regularly as they were beamed to Europe and the Middle East. Within seven years, broadcasts were go-

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*Netherlands Antilles Trans World R-Bonaire*  
Science & Electronics
ing out in 20 different languages and dialects
from the Tangiers studio, which since had
changed its name to Trans World Radio.

- In late 1959, when the Moroccan govern-
ment nationalized all radio facilities, TWR was
forced from Tangier, and for almost a year in-
terrupted its work. Dr. Freed finally found fa-
cilities in Monte Carlo, and restored programs
on Oct. 16, 1960. Intensifying his efforts,
TWR-Monaco soon was broadcasting evange-
listic programs in 31 tongues spoken on both
sides of the Iron Curtain of Europe and Arabic
dialects of the Mediterranean area. Eventually
he opened additional offices and studios in
Lebanon, France, Germany, Holland, Spain and
England.

- By 1962, TWR planned American facilities
and after studying the geography, decided that
the Netherlands Antilles islands off the South
American coast offered the best possible locale
for its new transmitters. Permission was ob-
tained to erect the necessary transmission
buildings and equipment on the tranquil island
of Bonaire. Funds were obtained and con-
struction began.

- Facilities include three giant transmitters:
one, for medium wave standard broadcasting is
a 500,000-watt unit. The other two are short-
wave: one with 260,000 watts, the other, 50,-
000 watts, to provide a total output power of
more than three-quarters of a million watts.

- There are 30 steel towers in what is called
an “antenna farm” all of which are used to
beam TWR broadcasts to the entire Western
Hemisphere, Europe, the Middle East, Africa,
India, Australia and deep into countries of the
Soviet-Communist bloc.

- Trans World Radio-Bonaire maintains a
staff of 93 dedicated and talented missionary
specialists who serve as program directors,
script writers, commentators, engineers, tech-
nicians. Bible teachers and follow-up workers.

- The Netherlands Antilles Postal Adminis-
tration intends to keep this pair of stamps on sale
until Feb. 4, 1972, unless stocks are exhausted
before then. Collectors may obtain them di-
rectly from the Philatelic Office of the PTT,
Willemstad, Curaco. NE.- by sending 13 (US
currency) for each pair desired.

- The Seychelles is a small cluster of Brit-
ish colonial islands—with a total acreage of less
than 100 square miles—off the African coast,
just north of Madagascar in the Indian Ocean.
But when NASA looked around the globe for
sites suitable as tracking stations to keep its
terrestrial eyes and ears on Space vehicles and
satellites, these insular specks were selected for
one of them.

- So, when Apollo XI’s Astronauts landed on
the Lunar surface, the Seychelles participated
in this epochal triumph.

- It was not surprising, then, that the islands
would authorize a set of stamps, not only to
commemorate Man's first walk on the moon,
but also to call attention to their part in track
ing the flight. The designs used for the king
size quintet are: 5 cent, Apollo XI launching at
Cape Kennedy; 20¢, separation of the Lunar
Module from Columbia; 50¢, Astronauts Al-
drin and Armstrong walking around the Lunar
surface near the Eagle; 2¼ Rupee, the earth as
seen from the moon's surface and craters. The
85-cent denomination shows the sophisticated
tracking station on the Seychelles.

And speaking of Apollo XI stamps, one of
the more striking ones of the hundreds de-
dsigned for various nations, is that turned out by
the small East African republic of Rwanda. The
100-franc stamp is set in the middle of a small
sheet, with the picture running over into the
margins. Shown is Col. Armstrong holding a
TV camera at the foot of the Eagle, as Colum-
bia orbits above. The flag of the United States,
with its prop support, and the Astronauts' foot-
steps form side and bottom patterns.

What's New?
• Conscious of collectors' desires, now that
hundreds of stamps have been released by
countries in all parts of the world to com-
memorate the first Lunar stroll by American
Astronauts Neil Armstrong and Buzz Aldrin,
the Washington Press, of Maplewood, N.J.
07040, has added a "Moon Landing" volume to
its "White Ace Album" series.

• Its pages, attractively illustrated and anno-
tated, contain spaces for all stamps issued so
far. Punched so they will fit any standard three
ring binder (or the special one also produced
by Washington Press) the pages alone cost only
$1.85, and are available from most stamp deal-
ers.

• The H. E. Harris Company, one of the
world's largest stamp firms, is marking the
54th anniversary of its establishment by selling
more than 2,500 of the world's most popular
rarities and classics at discounts of up to 40%.
A list of items available will be sent to inter-
ested collectors who write to the firm, Boston,
Mass. 02117 and mention the Stamp Shack.

Also, H. E. Harris & Co. offer the best ten
cent offer in the United States! It's the 1970
Edition of the Harris illustrated Collector's Catalog. This catalog includes up-to-date prices
on U.S. postage stamps plus many new special
listing, and accurately reflects the current active
market for United States stamps. Get your copy
today!

Rwanda Man-on-Moon Sheet
Steer to Stereo

The star of Utah Electronics' broadened line of display-packed speakers is the SA-55, a deluxe stereo auto kit for car-door installation. The unit features cloth roll cone suspension, 5.5-oz. ceramic magnets, separate high frequency cones, and snap-on chrome grilles which eliminate all visible fastening devices. All its features are presented on the pack, so you don't have to go hunting up an un-busy salesperson. The SA-55 sells for $29.95 and you can write for more information to Utah Electronics, 1124 E. Franklin St., Huntington, Ind. 46750.

Mod, Mod Modular

Here's a hot combo from Lafayette Electronics, the LSC-45 stereo modular hi-fi phono system. It combines a Garrard 4-speed auto-
NEW PRODUCTS

Lafayette LSC-45 Stereo Phono System

Lafayette's LSC-45 stereo phonograph system consists of an automatic record changer, a 20-watt solid-state stereo amplifier, and a pair of acoustically matched speaker systems. The record changer has a tubular tone arm with stereo turnover cartridge and diamond LP needle, plus cueing control. It will play 7-, 10-, and 12-inch records at 16⅔, 33⅓, 45, and 78 rpm. Amplifier controls include Balance, Bass, Treble, Volume, Selector, Automatic Shut-off Switch, front panel stereo phone jack, auxiliary input jack for tuner or tape recorder. The speakers are 8-in. and you get a plastic dust cover, 45-rpm spindle, and speaker cable. The LSC-45 has walnut veneer cabinetry and the price is $99.95 for all. Write for further specs to Lafayette Radio Electronics, 111 Jericho Tpke., Syosset, N.Y. 11791.

Get Your Signals Straight!

EICO's Model 150 solid-state signal tracer is just what the doctor ordered for troubleshooting AM, FM and TV receivers as well as hi-fi and PA systems. There are two separate probes for testing both radio and audio frequency circuits. Results are judged from an audible output from an 8-ohm speaker or visually from a built-in meter. The unit has 400-mW continuous power output; power requirements are 105-132 VAC, 50-60 Hz, 5 VA. Handy-dandy size is 7½ x 8½ x 5 in., weight a mere 6 lb. Model 150 sells for $49.95 in kit form, $69.95 wired. For more info write to EICO Electronic Instrument Co., Inc., 283 Malta St., Brooklyn, N.Y. 11207.

Cleaner Heads Will Prevail

Robins Industries has come out with what they call "a pair of new combos and a couple of singles." The combos include the Test-N-Clean cassette Model THC-6 and cartridge Model THC-8, both listing at $2.80. They'll remove accumulated oxide, grime and foreign matter and test heads for both alignment and stereo balance between channels. For gentler head cleaning, there's the lintless, non-woven polyester cloth Head-Kleen cassette Model THC-4, which sells for $3.00. Finally, there's the Head-Kleen cartridge Model THC-7, which cleans by means of polishing tape and sells for $2.50. For more information write to Robins Industries Corp., 15-58 127th St., College Point, N.Y. 11356.

Switched-on Saser Beam

The Saser Beam antenna line, says Mosley Electronics, cuts through CB interference like a laser cuts through steel. Model DMS-3D is
a deluxe 12-element Saser Beam, a combination of two MS-3D beams stacked, and features the sturdy construction of a beam plus the choice of polarization usually found only in the quad design. Each of the six horizontal and six vertical elements has two high "Q" coils, so powerful they can be used on a 10-meter ham antenna. A double "T" matching system provides balanced feed horizontally and vertically. A turn of the dial of the polarization switching control, located at the transceiver, permits selection of polarization. Complete with color-coded parts and instructions, the DMS-3D is priced at $198.41. For complete specs, write Mosley Electronics Inc., 4610 N. Lindbergh Blvd., Bridgeton, Mo. 63042.

More CB Power

Shown is one of a complete new line of CB beams from Cush Craft, featuring high forward gain plus excellent side and back rejection. Their new design makes for more strength with less weight and wind load. Called Power Beams, they have 2-in. mast-mount pre-drilled and pre-marked components, heavy wall seamless aluminum tubing and KW matching. A stacking kit for mounting any two Power Beams is available. Prices go as follows: 3-element, 8 dB gain @ $32.50; 4-element, 9.5 dB gain @ $42.50; 5 element, 10.5 dB gain @ $69.50. The dual beam stacking kit is $49.50. Write for Citizens Band antenna catalog C-17 to Cush-Craft, 621 Hayward St., Manchester, N.H. 03103.
NEW PRODUCTS

Quick-Mount Flush Speaker
Those Poly-Planar people have come out with a new quick-mount speaker/grille assembly, model G51P. It's designed to permit customized surface or flush mounting with a minimum of effort by means of newly engineered mounting brackets and grille. The G51P requires only ⅝-in. mounting depth—great for custom-mounting in walls, ceilings, furniture, doors, under eaves. With its new brackets, no cutout of the mounting surface is required, and the brackets form a natural sound chamber. Unit can be mounted in a few minutes. The Poly-Planar G51P has a power handling capacity of 5 watts, frequency range of 60 Hz to 20 kHz and input impedance of 8 ohms. Size of grille is 6 x 10 in., it comes in ivory, walnut, and black, and sells for under $11.00. For more information write the Magitran Co., Moonachie, N.J. 07074.

100 Watts! Outa Sight!
The new Heathkit AR-29 AM/FM/FM-Stereo receiver kit is the result of a two-year project, and, they say, borrows liberally from the technology of the Heathkit AR-15. The AR-29 features FET and IC designs, ultrasensitive FM tuner, selective IF design, built-in test circuitry, and the first use of computer-designed fixed-tuned L-C IF filters. Frequency response is 5 to 30,000 Hz with less than 0.25% harmonic distortion at any power level. There's a regulated power supply, and 4 heavy-duty individually heat-sinked output transistor protected against short-circuit conditions by a special dissipation-limiting circuit. Then there's a big break for the kit builder in the form of plug-in circuit boards, which simplify checking of circuits. You can eliminate on-station FM background noise and harsh noise bursts between stations by pushing a button activating the Noise Muters. Styling features the Black Magic panel lighting, revealing no dial or scale markings until set is turned on. The AR-29 is priced at $285.00 and for further information, write Heath Co., Benton Harbor, Mich. 49022.

Cordless Brilliance
Campers, boaters, outdoor livers, patio partyers, and just plain folk who have a power failure now and then will welcome the Porta Lite from Marathon Battery. Attractively styled, it's powered by a 6-volt No. 896 Marathon battery, molded from polyethylene in green or blue, and its No. 1651 bulb provides up to 100 hours of intermittent light. The shade can be moved up or down and there's a hang-up loop. Price is $10.99 and for complete information contact Marathon Battery Co., Box 1246, Wausau, Wis. 54401.
Maybe someday the other guys will have a guaranteed, million dollar reservation system like Max. Maybe.

When the other guys reserve a car for you, they assume it'll be there. National knows. Because right now—today—National has Max, a million dollar computer.

Max knows the whereabouts of every car in our fleet. When you call us toll-free at 800-328-4567, Max tells us instantly what's available so we can guarantee your reservation.

Max isn't the only difference, either. National has GM cars, S&H Green Stamps and a trusting nature that prompts them to accept any recognized credit card at any of their 1800 locations.

Maybe someday the other guys will have all of those things. But why wait? National guarantees your reservations now!

We make the customer No. 1
Solid Ignition
How good are transistorized ignitions?
—J.P., Kansas City, Kans.

Excellent. You can buy kits by mail (watch the ads) or at auto accessory stores. If you’re buying a new car, get a Detroit-installed unit.

Cheap Is Cheap
Is there any way I can modify my low-cost electronic organ for under $200.00 to make it sound like a Hammond?
—K.E., Kirkland Lake, Ontario

Add a phono jack and play Hammond organ records through the amplifier and speakers. Otherwise, trade it in for a Hammond. If you would like to build an organ from a kit, then think about getting catalogs from Heath Co., Benton Harbor, Mich. 49022 and Schober Organ Corp., 43 W. 61st St., New York, N.Y. 10023.

101 Projects
Where can I get a handbook of circuit diagrams for projects that really work?
—P.S., Brooklyn, N.Y.

The Editor of Science and Electronics is currently preparing a new annual magazine to go on sale the same time as this issue, just about. The title is long—101 Electronic Projects for Under $10—and so will be the time you retain this magazine as a reference. The projects were not picked up from other references as so many do. Each project has been wired and tested from parts that are currently easy to obtain. There are no CK-722 or 2N107 transistors that are impossible to find and date the projects to pre-1960. Pick up a copy and see why we are so excited about it.

Tricky Quiz
When I took a test for a job as a technician, I was shown a diagram and asked to state how many amperes flow in the circuit. I don’t dig it. What is the current?
—C.B., Rome, N.Y.

Redraw the diagram. The three resistors are in parallel and their total resistance is one ohm. The current must be 3 amperes since 3 volts applied to 1 ohm causes 3 amperes to flow.

50-Foot DXer
I would like to play my cassette tapes through a wireless oscillator so they can be tuned in with an AM-BCB radio. Can you give me a circuit?
—C.H., Chicago, Ill.

Why build when you can pick up a module for either AM or FM transmission? They’re cheaper parts and work first time the battery’s plugged in.

One-Up-Manship
Can you tell me how to increase the selectivity of my inexpensive FM receiver (see diagram) I use for listening to the sound channel of TV stations? As my diagram shows, it demodulates FM using the slope detection principle. At 1000-ft. elevation, I can pick up Channel 4 and 9 six miles away.
—D.B., Chelsea, Quebec

Your simple circuit is a very clever design. To get more selectivity, you need more tuned circuits than you have now. Perhaps the easiest way is to add a regenerative RF amplifier ahead of the slope detector (see our circuit). This increases the Q of the loop. The transistor is a field-effect type (FET). The 10,000-ohm potentiometer is the regeneration control which should be set just below the point where oscillation occurs. Choke L1 can be homemade. Wind a few turns of hook-up wire around a 1-watt carbon resistor. Try various numbers of turns until enough regeneration is obtained.

Science & Electronics
Here's an Old One

I have an old all-wave Silvertone radio, model 1570, which uses two 230, four 232, and one 233 tubes. The schematic shows a ballast. It was made by Radio Corporation of America, according to the patent sticker on the rear of the cabinet. I hope you can suggest a power supply for it.

—W. E. S., Reisterstown, Md.

The patent sticker only means that the actual manufacturer who made it for Sears, Roebuck & Co., had paid patent royalties to RCA. Your set requires 2 VDC for the filaments, 180 VDC for the plates, 67.5 VDC for the screens, and -3 V, -13.5 V, and -18 V for grid bias. Since you said there is a ballast, it probably is used to drop the voltage from 3 volts to a 2-volt battery. One good source for diagrams for old receivers is Supreme Publications, 1760 Balsam Rd., Highland Park, Ill. 60035. Why not write to them?

Some Call It Pot

What is the difference between a gain control and a volume control?

—E.T., Washington, D.C.

Many call a volume control a gain control. Often, and they are wrong. A volume control can be a level control as in diagram A and B. The potentiometer shown in A is not a gain control since its setting does not vary the gain of the amplifier itself. The potentiometer in B, an integral part of an amplifier containing a preamplifier, does vary overall amplifier gain even if it controls the output signal level of the preamp stage. The potentiometers in C and D are true gain controls; in C the pot controls grid bias, and in D the pot controls screen voltage to alter the gain of the tube and amplifier stage.

Transistor Subs

Where can I get a list of transistor substitution situations?

—C. C. M., Yucca Valley, Calif.

You can buy a copy of "Popular Tube/Transistor Substitution Guide" for $4.95 at most radio parts distributors or by mail from TAB Books, Blue Ridge Summit, Pa. 17214.

Down With Code

I read in Wireless World that a British subject can get a ham license to operate phone only without having to take a code test. But, I understand that the FCC won't issue a ham ticket without the applicant passing a code test because of an international agreement. Isn't England bound by the same agreement? What
Look! You get 25 kits...more than ever before at no extra cost...for your practical "hands-on" learning of electronics and TV with RCA Institutes Home Training! Send postcard today!
Now, RCA supplies 25 kits in its home-study career program—at no extra cost! Be sure to compare this with other home-study electronics programs. And note, you never have to take apart one kit to build another piece of equipment because there are literally thousands of parts making up the kits. Information on them is included in the catalogue which you’ll get when you mail in the reply postcard or the coupon. Absolutely practical, your kits are used to build such permanent, professional and useful equipment as an oscilloscope, a signal generator, a multimeter, and a fully transistorized breadboard superheterodyne AM receiver. They will give you years of valuable service.

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ASK ME ANOTHER

Continued from page 17

can be done about getting the FCC to relax its stiff position and issue ham tickets without a code test and allow beginner hams to operate phone on some bands?


Many hams, through their American Radio Relay League lobby, fight any move to relax ham rules. We don't agree with them. Many frustrated CBers would rush out and buy ham rigs if the FCC would abolish the code test. Write to Hon. Dean Burch, Chairman, Federal Communications Commission, Washington, D. C. 20554, and tell him how you feel. Also write to your Congressman and Senators. The more people that write, the greater the chance of getting action.

Ham Bands Are Better

Can I modify an old 2-3 MHz marine radio-telephone into a CB transceiver?


No, not easily. In the first place it is higher powered than a CB rig. The modifications would be extensive and expensive. Furthermore, you would have to get it tested in a lab and submit full technical data to the FCC. On the other hand, it would be easy to modify it for the 80-Meter or 160-Meter ham bands by simply installing new crystals and retuning.

You Take the Low Road

I was told that the distorted reception I am encountering from some FM stations is due to multi-path reception. What’s that?

—S.E., Palo Alto, Calif.

Vhf band signals from FM stations can travel direct (line-of-sight conditions from transmitting antenna to receiving antenna) and via reflected paths (see diagram). The signals could arrive at your antenna at the same time and be out of phase with each other. This can cause distortion and, when signals oppose each other, received signal level can be reduced. The cure is to use a directional FM antenna, preferably with a rotator. You can then pick up the strongest signal and attenuate the weaker ones that intermingle with the desired signal and cause distortion. Multi-path reception is the same trouble that causes ghosts on TV. 

☆☆ By this time, the readers of this regular department for the past several months will be getting to know how the sky behaves. In February, Leo was low in the east, sitting up like a “nice doggie,” perhaps begging Hercules not to strangle him, for this constellation represents the lion which was slain by the great hero as the first of his famous “twelve labors.” The picture is not quite exact, however, as we can see in the April map, where Hercules is now seen low in the east and trails Leo, who swings high overhead, perhaps trying to escape.

☆☆ If you have a clear night and you don’t have the map handy, here’s the way to find Leo if, as almost everyone does, you know the Big Dipper and how the line drawn through the “pointers,” as the two stars in the front of the “cup” of the dipper are called, point the way to the North Star. Just draw that pointer line the other way, about the same distance, and you’ll end up in the middle of the back of Leo. The sickle-formed group of stars marks his head, with Regulus in his chest; the triangle indicates his hind-parts, with Denebola the tuft or brush at the tip of his tail.

☆☆ The format for this series that I have adopted has been one in which, after a look-see at the current sky, I pick a theme for an essay on some facet of astronomy—preferably one that may answer some questions that have been lurking in the minds of my readers, perhaps even without their knowing it. In December-January, it was meteors; in February-March, it was the March 7 solar eclipse, which I hope you may yet enjoy, if you haven’t already seen it.

☆☆ This time, the topic is one that might better have appeared earlier, except that, with the normal schedule of publication, it still is appropriate, because the great religions, the Hebrew and the Christian, celebrate solemn festivals in the spring of the year, and the dates...
of these festivals are astronomically based, since ancient times.

☆ When I am asked, as I often am, "What good is astronomy?" I try to avoid the obvious answers, preferring to think of what the scanning and, little by little, the understanding of the workings of the universe have meant to the progress of civilization, not only practically but philosophically as well.

☆ The whole business of timekeeping arose from necessity, as early man discovered that community living offered certain advantages over that of small family groups. Today it is recognized as one of the four master measures by which man senses, understands and, in some measures, relates to his environment—the universe and all it contains. The units of length, mass, temperature and time and their measurement are the stuff of physical scientific research, whether applied or, as we say, "PURE."

☆ But let's go back to the beginning of the dissemination of concepts of timekeeping. We are told that the prophet Abraham (originally Abram) was born in the city of Ur, in Chaldea, not long before 1800 B.C. Civilization had been developing in the Tigris-Euphrates valley (Mesopotamia—"between the rivers") for about three millenia before that time and it seems almost certain that timekeeping devices such as sundials and calendars were either invented there or imported from even farther east, perhaps from the valley of the Indus river, that flows southward through the length of modern West Pakistan, to flow into the Arabian Sea. Abraham's father, Terah, took him, his wife Sarah and other members of the family first into Canaan, to a place about 75 miles northeast of modern Tel Aviv, where Terah died. Abraham then wandered his way with Sarah and his band into the Negev, but "there was a famine in the land" and they went on into Egypt, where they were well treated and prospered, for at least a year or two.

☆ Then they all left Egypt and returned to the place where they had first stopped in Canaan. Nearby, Abraham died, but not before he had had two notable sons—Ismael, the progenitor of the Islamic people, and Isaac, the founder of the Hebrews.

☆ These historical notes have been given here to explain why, perhaps, our earliest known sundials are from Egypt. With what the Egyptians already knew, and what Abraham could tell them of the Sumerian astronomy, the scholars of the Nile valley were eventually able to contribute concepts of time measurement to Europe and thus to all of the world. Next time I'll tell you how to make a simple but workable and very interesting sundial, designed after the earliest type positively known, dating from the reign of Thothmes III, who ruled Egypt about 1500 B.C.

☆ But it seems strange that more of the Egyptian knowledge did not rub off on Abraham. At least a thousand years before his brief sojourn in Egypt, his hosts had known that the annual flooding of the Nile valley occurred at regular intervals of about 365 days, which they divided into 12 months of 30 days each, with five extra days to make up the total. In about 2776 B.C., it was noticed that the spring monsoons and the melting of the snows in the mountains of Ethiopia fed more water into what is called the Blue Nile and the waters rose, bringing life-giving new silt for the next year's crops. The flooding began when the Star Sirius, the brightest in all the sky, rose with the sun. (Turn page)

THE NIGHT SKY IN APRIL

☆☆☆ The maps show the principal stars which are above the horizon at latitude 34° North at about 9 p.m. standard time at the middle of the month. These maps are practical star location guides anywhere in the United States throughout the month showing the sky at 10 p.m. on the first and at 8 p.m. on the last of the month. To look at the night sky in April and May (page 24), select the proper map and hold it vertically. Then turn the map so that the point of the compass toward which you are facing shows at the bottom of the map.

☆☆☆ Our special thanks go to the Griffith Observatory in Los Angeles, California. ☆☆☆
THE SKIES ABOVE US

☆ For more than two thousand years before Abraham, the Egyptians were a sedentary people, tending their crops and their flocks and fishing in the life-giving Nile. The orderly flow of the seasons was most important to them and, while in their twelve-month calendar they paid a small tribute to the moon whose recurring phases may have served them earlier, they finally dropped the phases of the moon.

☆ It was very different with the descendants of Ishmael and Isaac, who adhered to the moon as the primary timekeeper and do even today, in establishing their religious festivals. Of course, for communication with others outside their faiths in business matters, Arabs, Jews, Hindus, Chinese, and Christians all use a common calendar, the one that hangs on our walls and considers January 1 as New Year’s Day and the current year as 1970.

☆ But about one-sixth of the world’s population celebrates the beginning of the Islamic (Mohammedan) year 1390 on March 9, this year. Another 15 million people, the Hebrews, celebrated Rosh Hashanah (1 Tishri), the beginning of the year 5730, on September 13 last year; New Year’s Day for 5731 will fall on October 1, 1970. These two calendars have been singled out at this moment to point up their similarities and their differences. Also, as a scientist, I should not fail to remind you that, as all those born as Christians are not members of churches, many Hebrews are not associated with synagogues nor are all Islames faithful to their mosques or ritual devotions.

☆ The Mohammedan calendar ignores the year of the seasons and adheres strictly to the phases of the moon for counting of the years. If the earth and moon were isolated in space, the moon at its present distance would revolve around the common center of gravity of the earth and moon in 27.3217 days. But we’re rather close to the sun, and this period varies because of the gravitational interference from our star, which is about 330,000 times as massive as the combined earth-moon system. Similarly, the period of the moon’s phases must vary from about 29 days 6 hours to 29 days 20 hours. Over a long period of time, the average interval between new moons or between full moons comes out as 29 days 12 hours 44 minutes, or 29.306 days.

☆ The Mohammedan calendar tries to keep in step with this, with 12 months alternately 30 and 29 days long, but to make up for an error of almost nine hours, an extra day is added to the last month, 11 times in 30 Mohammedan years, bringing the average lunar month up to 29.306 days which, as we can see, is the true average length of the cycle of the phases.

☆ But the length of the year of the seasons is 365.2422 days, while the average length of the Mohammedan religious year of 12 lunar months is only 354.3672 days, which falls short by 10 days 21 hours. The Mohammedans make no attempt to match the seasons with their calendar of religious celebrations, so in 33 Islamic years the gain accumulates to 359 days. If you happen to meet a Mohammedan who says he is 33 years old, he may really have seen only 32 cycles of seasons.

☆ The Hebrew calendar certainly must be different, as we can quickly see from the dates given for the beginnings of the years 5730 and 5731; the interval is 383 days. But this is not a regular occurrence; 5730 is an "embolismic" year—one in which an addition is made to maintain a proper average length. We have seen that the Mohammedan insertion of an extra day at the end of each 11 years in each 30 keeps the lunar month, on the average, in step with the actual phases of the moon. In our familiar so-called Gregorian calendar we are familiar with the insertion of an extra day at the end of short-changed February each four years (except in those end-of-century years that can not be divided exactly by 400);
this keeps the calendar closely in step with the seasons. This kind of embolism is a good one; medical men use the word for a bad malfunction.

In the Jewish calendar, the insertion is that of a whole month, according to a regular schedule that adds an extra month in seven of the years in a cycle of 19 years. There are 6939.6018 days in 19 years of the seasons and, with 12 lunar months in 12 years and 13 in the remaining 7, the total of the 235 months of 29.5306 days each comes to 6939.6910 days, an excess of 2 hours and a little more than 8 minutes. The average year is only 6.768 minutes too long, which builds up to a whole day in about 213 years. But by a judicious manipulation of the numbers of days in the months, even this small error can be forestalled.

There are two kinds of Jewish years; what we may call the civil year is the one that will begin on October 1 and it bears the official number. But the spiritual or sacred year begins in the spring. In ordinary years it begins at 1 Nisan, following the twelfth month, Adar, of the preceding month, and is the month in which the fourteenth day, when the full moon occurs, falls after March 21, when spring begins. In embolismic years, the thirteenth month follows Adar and is called a second Adar, or Adar II—sometimes called Ve-Adar—and it is still 1 Nisan that opens the new sacred year.

The stars and time are endless. But, alas, this is not so for the space available to this columnist. So, we'll just have to continue our time discussion in the next issue of SCIENCE AND ELECTRONICS.

5. Edmund Scientific's new catalog contains over 4000 products that embrace many interests and fields. It's a 148-page buyer's guide for Science Fair fans.

4. Olson's catalog is a multi-colored newspaper that's packed with more bargains than a phone book has names. Don't believe us? Get a copy.

1. Allied's catalog is so widely used as a reference book that it's regarded as a standard by people in the electronics industry. Don't you have the 1970 Allied Radio catalog? The surprising thing is that it's free!

7. Before you build from scratch, check the Fair Radio Sales latest catalog for electronic gear that can be modified to your needs. Fair way to save cash.

8. Get it now! John Methoa, Jr.'s new 96-page catalog is jam packed with surplus buys—surplus radios, new parts, computer parts, etc.

1. How cheap is cheap? Well, take a gander at Cornell Electronics' latest catalog. It's packed with bargains like 6W4, 12AX7, 5U4, etc., tubes for only 33¢. You've got to see this one to believe it!

35. RCA Experimenters' Kits for hobbyists, hams, technicians and students are the answer for successful and enjoyable building, creating, experimentating and learning. Find out for yourself by circling 135 now!

106. With 70 million TV and 240 million radios somewhere somebody will need a vacuum tube replacement at the rate of one a second! Get Universal Tube Co.'s Troubleshooting Chart and facts on their $1.50 flat rate per tube.

10. Burstein-Appelbee offers a new giant catalog containing 100s of big pages crammed with savings including hundreds of bargains on hi-fi kits, power tools, tubes, and parts.

11. Now available from EDI (Electronic Distributors, Inc.): a catalog containing hundreds of electronic items EDI will be happy to place you on their mailing list.

6. Bargains galore, that's what's in store! Poly-Paks Co. will send you their latest 8-page flyer check full of Poly-Paks' new $1.00 electronic and scientific "bliss-dor" paks and equipment.

23. No electronics bargain hunter should be caught without the 1970 copy of Radio Shack's catalog. Some equipment and kit offers are so low, they look like misprints. Buying is believing.

LITERATURE

102. No never mind what brand your CB set is, Sentry has the crystal you need. Same goes for ham rigs. Seeing is believing, so get Sentry's catalog today. Circle 166.

146. It may be the first-Gilter's special catalog catering to the SWL. Books, rigs, what-nots—everything you need for your listening post. Go Gilter, circle 146!

100. You can get increased CB range and clarity using the "Cobra-23" transceiver with speech compressor-receiver sensitivity is excellent. Catalog sheet will be mailed by B&K Division of Dynamac Corporation.

141. Newly-designed CB antenna catalog by Antenna Specialists has been sectionalized to facilitate the picking of an antenna or accessory from a hand. Man, Antenna Specialists makes the picking' easy.

130. Bone up on the CB with the latest Sams books. Titles range from "ABC's of CB Radio" to "69 Ways to Improve your CB Radio." So circle 130 and get the facts from Sams.

107. Want a deluxe CB base station? Then get the specs on Tram's all new Titan II—it's the SSB/AM rig you've been waiting for!


129. Boy, oh boy—if you want to read about a flock of CB winners, get your hands on Lafayette's new 1970 catalog. Lafayette has CB sets for all pocketbooks.

46. Pick up Hallcrafters' new four-page illustrated brochure describing Hallcrafters' line of monitor receivers—police, fire, ambulance, emergency, weather, business radio, all yours at the flip of a dial.


48. Hy-Gain's new CB antenna catalog is packed full of useful information and product data that every CBer should know. Get a copy.

111. Get the scoop on Verite-Tronics' Venna-Tenna with instant magnet mounting. Antenna models available for CBers, hams and mobile units from 27 MHz to 1000 MHz.

45. CBers, Hams, SWLs—get your copy of World Radio Labs 1970 catalog. If you're a wireless nut or experimenter, you'll take to this catalog.

101. If it's a CB product, chances are International Crystal has it listed in their colorful catalog. Whether kit or wired, accessory or test gear, this CB-oriented company can be relied on to fill the bill.

103. Squires-Sanders would like you to know about their CB transceivers, the "23"s" and the new "58." Also, CB accessories that add versatility to their 5-watters.

TOOLS

78. Need pliers to hold, bend or cut fine wires? Check Xcelite's new line of miniatures shown in Catalog 166 along with a complete selection of regular pliers and snips.

118. Secure coax cables, speaker wires, phone wires, etc., with Arrow staple gun takers. 3 models for wires and cables from 3/16" to 3/8" dia. Get fact-full Arrow literature.

ELECTRONIC PRODUCTS

143. Bring new life to your hobby. Exciting plans for new projects—let New England Hobby Shop give you the dope. Circle 143, now.

44. Kit builder? Like wired products? EICO's 1970 catalog takes care of both breeds of buyers. 32 pages full of hi-fi, test, CB, ham, SWL, automotive and hobby kits and products—do you have a copy?

42. Heath's new 1970 full-color catalog is a shopper's dream. Its 116 pages are chock full of gadgets and goodies everyone would want to own. Mostly kits are shown but many factory-wired products are available. Get your catalog today!

144. Hear today the organ with the "Sound of Tomorrow" from Sonic by Whippány Electronics. It's portable—take it anywhere. Send for pictorial descriptive literature.

12. C. B. Hanton new Automatic Control records both sides of a telephone call automatically—turns off automatically, too! Get all the details—today!

126. Did you dig Delta's new litera-
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1. Prepare for tomorrow by studying at home with Technical Training International. Get the facts today on how you can step up in your present job.

2. For success in communications, broadcasting and electronics get your First Class FCC license and Grantham School of Electronics will show you how. Interesting booklets are yours for the asking.

3. How to get a Commercial FCC License and "How to Succeed in Electronics" from Cleveland Institute of Electronics. Begin your future today!

4. Get the all the facts on Progressive Edu-Kits Home Radio Course. Build 20 radios and electronic circuits; parts, tools and instructions come with course.

5. Radio-Television Training of America prepares you for a career—not a job. 16 big kits help you learn as you build. 120 lessons. Get all the facts today!

6. Get with 1970's hi-fi jet set. H. H. Scott sets the pace with their fantastic line of audio components, some in kit form, too! Scott will send you their 20-page catalog if you circle 26!

7. You can't hear FM stereo unless your FM antenna can pull 'em in. Learn more and discover what's available from Fenchel's 5-pages "Third Dimensional Sound."

8. Kenwood puts it right on the line. The all-new Kenwood FM stereo receivers are described in a colorful booklet complete with easy-to-read-and-compare spec data. Get your copy today!

9. Mikes, speakers, amps, receivers—you name it,Electro-Voice makes it and makes it good. Get the straight poop from E-V today.

10. Get the inside info on why Koss Acoustech's solid-state amplifiers are the rage of the experts. Colorful brochure answers all your questions.

TAPE RECORDERS AND TAPE

11. You just gotta get Craig's new pocket-size, full-color folder illustrating what's new in home tape recorders—reel-to-reel, cartridge and cassette, you name it! It looks like a who's who for the tape industry.

12. For the asking—Elba's new "The Tape Recording Omnibook," 16 jam-packed pages on facts and tips you should know about before you buy a tape recorder.

13. All the facts about Concord Electronics Corp. tape recorders are yours for the asking in their free 1970 catalog. Portable, battery operated to four-track, fully transistorized stereo cover every recording need.

14. "All the Best from Sony" is an 8-page booklet describing Sony-Supertape products—tape recorders, microphones, tape and accessories. Get a copy today before you buy!

15. If you are a serious tape audiophile, you will be interested in the all new Viking Telex line of quality tape recorders.

TELEVISION

16. The all new Heathkit 1970 catalog is jammed with 7 color TV kits, plus buys on antennas, rotors, towers and other accessories, and TV test gear. Get your copy by circling item 70 below.

17. National Schools will help you learn all about color TV as you assemble their 25-in. color TV kit. Just one of National's many exciting and rewarding courses.

SCIENCE AND ELECTRONICS

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42 44 45 46 48 70 74 78 96 99
100 101 102 103 104 106 107 109 111 114
116 118 119 123 126 127 129 130 135 136
137 140 141 142 143 144 145 146

NAME
ADDRESS
CITY
STATE ZIP

APRIL/MAY 1970
HOW TO GET STARTED IN RADIO
by Jack Schmidt

... establish the need

... open a charge account

... pick an antenna site

... locate the studio

... plug it in

... get a license
"WINDY"
the
WIND GAUGE

by Edward A. Morris, WA2VLU

Peter, Paul and Mary made the tune "Blowing in the Wind" popular. But if you hope to find out just how fast the winds are a-blowing, the song's lyric won't help much. You'll need an anemometer. Until now, if you'd had a need for an anemometer (wind gauge) or wanted one just because you were interested in keeping tabs on the prevailing winds,
“WINDY”

you’d have had but two choices. Toy ones, though the price may be right, leave much to be desired in performance, reliability, and accuracy. On the other hand, the better-quality instruments, available from specialty stores, start at about $125.00 and increase in cost very fast.

With our Windy you bridge the gap. Its accuracy is 5% or better, and its cost is reasonable, being in the $30.00 range. Dual meter ranges cover 0-30 mph and 0-90 mph. Readout is indicated on a large, clear, easy-to-read meter scale. And its remote pickup head can be located up to 150 feet from the readout indicator.

Windy’s low cost and high accuracy are achieved through use of two integrated circuits (ICs), which together replace 12 transistors and 24 resistors. A novel optical sensor in the remote pickup head speeds construction by replacing a more complicated mechanical design.

How Windy Works. Whenever the wind blows, it revolves the windcups. The remote pickup head, built into the housing that supports the windcups, is a photoelectric pulse generator whose pulse rate is directly proportional to the speed of the wind. A disc, having holes punched uniformly around its edge, is fastened to the end of the shaft opposite the windcups. Mounted above this disc is a light source that shines through the perforations into a variable-resistance photocell positioned below the disc.

Photo above shows how Wind Cup generator is fastened to its mounting mast. Also, details on making the mounting bracket are shown. Photo below left illustrates how finger is used as a mandrel when punching holes in the polystyrene Wind Cups with a tool made by sharpening a piece of ¼-inch brass tubing. In the photo below right pointer shows where epoxy is placed to fasten Wind Cups to brass mounting rods. On the opposite page are construction details for the Wind Cup generator. Though not shown in the drawing, leads from lamp 12 must be tacked to side wall of jar to keep them away from the rotor disc, to prevent disc binding.
WIND CUP PULSE GENERATOR

BRASS ROTOR SHAFT
SOLDER

WIND CUP MOUNTING ROD

TOP BEARING SURFACE (SEE TEXT)

PLASTIC DRIP SHIELD

STRAIN DISTRIBUTION WASHER

5/32"OD X 1/8"X 1-5/8"L-

BRASS ROTOR SUPPORT TUBING

INTERRUPTER DISC

BRASS ROTOR SUPPORT TUBING

BRASS DISC

EPOXY CEMENT

PHOTO CELL MOUNTING BOARD

PLASTIC JAR

EPOXY CEMENT

-1/2" AND SOCKET

EPOXY CEMENT

1/4" TO 3/8"

1/8" TO 1/4"

PC1

3/4""

1/2"

INTERRUPTER DISC

EPOXY CEMENT

INTERRUPTER DISC

EPOXY CEMENT

INTERRUPTER DISC

EPOXY CEMENT

DETAIL SHOWS HOW INTERRUPTER DISC MOUNTED ON ROTOR SHAFT

MAKE 3 DISCS; 2 WITH 5/32" DIA. HOLES, 1 WITH 1/8" DIA. HOLE;

1/8"

1/4"

1-1/4"

1-5/8"

1/8"

1/8"

1/4"

2-1/4"

r = 1-7/8"

APRIL/MAY 1970
“WINDY”

disc directly under the light source (the disc is sandwiched between the light source and the photocell).

When the wind blows, the cups rotate the shaft, which, in turn, rotates the perforated disc. This allows light to alternately shine through to, and to be cut off from, the photocell. Each time light strikes the photocell, its resistance drops sharply. The photocell and resistor R3 form a voltage divider across the power source. When the resistance of the photocell is momentarily reduced by excitation from the light source, the voltage in that part of the divider is reduced. A pulse results from the sharp increase in current and resultant voltage drop.

This pulse triggers the hex inverter (IC1) which shapes and amplifies the pulse signals appearing across the voltage divider. The first inverter of IC1, biased by resistor R4, operates as a class-A amplifier. Succeeding stages are connected in cascade and operate with no bias. This considerably improves the input pulse rise and fall time that is necessary for accurate performance. A small amount of positive feedback in stages 4 and 5 further improves the rise and fall time of the pulses. Capacitor C3 on the input acts as a high-frequency filter, eliminating false triggering that could be created by spurious signals picked up in the long lead line.

Stages 3, 4, and 5 of the IC are wired as a one-shot multivibrator that is triggered by the shaped and amplified pulses from the previous stages.

The sharp input pulses from IC1 are differentiated by capacitor C6 and resistor R5. The leading edge of the pulse triggers a constant-width, monostable multivibrator, formed by three of the inverters in IC2. Each time the one-shot multi is triggered, it flips from its stable state to an unstable state. The amount of time that it remains in this unstable state is determined by the values of resistance and capacitance in the coupling network. The on time is set by range selection capacitors C7 and C8, calibration control R6, and resistor R7. The output pulse from the one-shot multi is buffered and inverted by the remaining three inverters in IC2, which are connected in cascade (see schematic for ICs).

Protected Meter. When the one-shot is triggered, the output at pin 7 from IC2 drops from 3.6 V, the supply voltage, to a mere few tenths of a volt. This effectively
grounds the end of resistor R8 connected to the IC, and a pulse of current flows through meter M1. As the wind picks up speed, the one-shot is triggered more often, directly in proportion to the wind speed. The pulse rate increases, and meter M1 and capacitor C9 integrate the output pulses into a wind speed reading. Should the voltage across the meter exceed 0.6 volt, diode D6 conducts, shunting current around the meter and protecting it from overload.

A Zener-diode regulated power supply provides +3.6 VDC power for the instrument. Output from the secondary of transformer T1 is rectified by a fullwave bridge rectifier comprised of diodes D1 through D4. Capacitor C1 brute-force filters the rectified output; Zener diode D6 holds the voltage on the base of transistor Q1 at 4.2 V. Since transistor Q1 is connected as an emitter follower, the filtered DC output appears on Q1's emitter. Low-voltage AC power to operate exciter lamp I2 is provided by the 6.3-V secondary winding of the power transformer.

Construction Tips. Prior to starting the actual fabrication of the various units comprising Windy, we suggest you study our photos and illustrations to familiarize yourself with the basic units, how they were constructed, and their relationship to one another. Take into account the dimensions shown in relation to materials you have readily available. It may be necessary for you to compromise somewhat in order to use available sources.

Epoxy cement contributes a great deal to the building of Windy. In order to receive the most benefits from epoxy cements, the resin and the hardener must be thoroughly mixed as quickly as possible. Try to use the new 5-minute curing epoxies; they'll speed up the waiting time.

The remote pickup head, which actually

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**PARTS LIST FOR WINDY’S PULSE GENERATOR**

<table>
<thead>
<tr>
<th>Description</th>
<th>Quantity</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>I2 755 single contact, miniature bayonet base, 6.3 V-0.15 A lamp bulb (Lafayette 3269032 or equiv.)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>P1 5-pin plug with hood and cable clamp (Amphenol 126-217 or equiv.)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>PC1 Photocell, Clairex C L-703L</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1 Miniature bayonet base, pilot lamp holder (Lafayette 3728079 or equiv.)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1 2% x 3½-in. plastic jar with screw-on cover</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1 2% x 9½ x ¼-in. plexiglas for mounting bracket (see text)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1 ¼-in. OD, ½-in. ID x ½-in. long plastic tubing for rain drip shield</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4 3-in. dia. light plastic half hemispheres</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>4 Pieces ½-in. OD x 6-in. long brass tubing</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1 Piece ½-in. OD, ⅜-in. ID x ½-in. long brass tubing</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1 Piece ½-in. OD, ½-in. ID x ¾-in. long brass tubing</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>3 ½-in. thick, half-hard brass discs, 1¼-in. OD (if discs not available cut from sheet brass)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>1 Bakelite disc ½-in. thick x 2½-in. dia.</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>2 x 1½-in. piece perfboard</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Misc. Length as required (not to exceed 150 ft.)</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Belden #8734 3-conductor cable with vinyl insulation and overall vinyl jacket (one conductor shielded), black spray paint, antenna mast mounting hardware (Lafayette 18E01950 or equiv.)</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

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**Schematic for Wind Cup generator.**

Cable may be extended to 150 ft.
The schematic at the top details the circuit for the indicator unit of Windy, except for its power supply. The diagram shows proper orientation for the IC's, looking down on them. The lower diagram details the power supply, which employs a 4.2 v Zener diode to regulate the output voltage that energizes the indicator unit electronics circuit.
is a windcup pulse generator, is housed in a small plastic jar, preferably one with a screw-type cover. To ensure that no extraneous light reaches the photocell, we recommend that you spray the jar and its cover with several coats of flat black paint to completely opaque it. (We purposely did our painting after completion of construction in order that details in construction would show-up better in our photos.)

Drill a \( \frac{3}{8} \)-in. hole in the lid of the jar to permit the lead cable to exit from the jar. Also drill the same size hole in the exact center of the bottom of the jar.

You'll need three discs made from \( \frac{3}{8} \)-in. thick half-hard brass. The outside diameter of the discs is \( 1\frac{1}{4} \)-in. Two should have a \( \frac{3}{8} \)-in. hole drilled at the exact center; the remaining one should have a \( \frac{1}{2} \)-in. diameter hole drilled in its center. One of the discs with a \( \frac{3}{8} \)-in. hole serves as a strain distribution washer. The center holes in the strain washer and the bottom of the cup must be aligned to permit bearing support tubing to pass through both easily for free shaft rotation.

Prepare the bearing support tubing, made from a \( 1\frac{1}{8} \)-in. length of \( \frac{3}{8} \)-in. OD, \( \frac{1}{6} \)-in. ID brass tubing for mounting in the base of the cup. It's important that the inner and outer surface of one end of this piece of tubing be as smooth as possible, since these surfaces are top bearing surfaces. The tubing should be chucking in a slow-speed drill (400-600 rpm) and smoothed both on inner and outer surfaces with a fine needle file. Bring the file against the rotating tubing to create a smoothed radius on one end.

We cannot emphasize too strongly the importance of a smooth surface for the bearing support tubing. Rough spots at this point can create future trouble either by slowing down the rotor because whatever produced the rough spot gouged the surface of the support bearing disc or, perhaps, when the atmosphere is quite humid and the temperature drops suddenly, the moisture trapped between the gouge in the disc and the bearing support tubing freezes and stops the rotor completely.

Cement this bearing support tubing in position to the bottom of the plastic jar with a blob of epoxy spread uniformly around the tubing both inside and outside the plastic jar to give added support to the bearing. The end of the tubing with the smoothed

### PARTS LIST FOR WINDY’S INDICATOR

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td>C1</td>
<td>500-uf, 15-VDC electrolytic capacitor (Sprague TVA1162 or equiv.)</td>
</tr>
<tr>
<td>C2</td>
<td>290-uf, 12-VDC electrolytic capacitor (Sprague TE1139 or equiv.)</td>
</tr>
<tr>
<td>C3</td>
<td>10-uf, 15-VDC electrolytic capacitor (Sprague TE1155 or equiv.)</td>
</tr>
<tr>
<td>C5</td>
<td>0.05-uf, 12-VDC ceramic (Erie 5635-000 Y5FD-503M or equiv.)</td>
</tr>
<tr>
<td>C6</td>
<td>0.001-uf, 100-VDC ceramic capacitor (Erie 001-000X5FD102K or equiv.)</td>
</tr>
<tr>
<td>C7</td>
<td>0.22-uf, 12-VDC ceramic capacitor (Erie 5615-000Y5FD224M or equiv.)</td>
</tr>
<tr>
<td>C8</td>
<td>0.47-uf, 200-VDC capacitor (Aerovox V1462-134 or equiv.)</td>
</tr>
<tr>
<td>C9</td>
<td>2000-uf, 25-VDC electrolytic capacitor (Cornell Dubilier BR2000-25 or equiv.)</td>
</tr>
<tr>
<td>C10</td>
<td>0.1 uf, 12VDC ceramic capacitor (Erie 5635-000-Y5FD-104M)</td>
</tr>
<tr>
<td>D1</td>
<td>N40001 silicon diode, 50 PIV, 1 A</td>
</tr>
<tr>
<td>D5</td>
<td>IN4731 Zener diode, 4.2 volt, 1 watt, 10% tolerance</td>
</tr>
<tr>
<td>F1</td>
<td>Fuse, type 3AG, 1/4 A</td>
</tr>
<tr>
<td>I1</td>
<td>Neon pilot lamp assembly, amber lens caps (Lafayette 34E52174 or equiv.)</td>
</tr>
<tr>
<td>IC1</td>
<td>IC2 Intergrated circuit, hex inverter (Motorola MC7899)</td>
</tr>
<tr>
<td>J1</td>
<td>5-pin chassis socket (Amphenol 126-218 or equiv.)</td>
</tr>
<tr>
<td>M1</td>
<td>0.1 mA meter (3 x 4 1/2-in.) 100 ohms or less coil resistance (see text)</td>
</tr>
<tr>
<td>Q1</td>
<td>Npn silicon transistor, type 2N697</td>
</tr>
<tr>
<td>R1</td>
<td>82-ohm, ( \frac{1}{2} )-watt resistor</td>
</tr>
<tr>
<td>R2</td>
<td>1800-ohm, ( \frac{1}{2} )-watt resistor</td>
</tr>
<tr>
<td>R3</td>
<td>15,000-ohm, ( \frac{1}{2} )-watt resistor</td>
</tr>
<tr>
<td>R4</td>
<td>39,000-ohm, ( \frac{1}{2} )-watt resistor</td>
</tr>
<tr>
<td>R5</td>
<td>1000-ohm, ( \frac{1}{2} )-watt resistor</td>
</tr>
<tr>
<td>R6</td>
<td>10,000-ohm, PC board mounted miniature potentiometer (Mallory MTC141 or equiv.)</td>
</tr>
<tr>
<td>R7</td>
<td>2200-ohm, ( \frac{1}{2} )-watt resistor</td>
</tr>
<tr>
<td>R8</td>
<td>470-ohm, ( \frac{1}{2} )-watt resistor</td>
</tr>
<tr>
<td>S1</td>
<td>S2 Spst rocker type switch (Cutler Hammer 81444K21A1M52 or equiv.)</td>
</tr>
<tr>
<td>T1</td>
<td>Low voltage power transformer; primary 117 V, 50/60 Hz, secondary 6.3 VAC at 0.6 A  (Stancor D6465 or equiv.)</td>
</tr>
<tr>
<td>T2</td>
<td>Aluminum minibox 4 x 5 x 6-in. (Lafayette 12E83746 or equiv.—see text)</td>
</tr>
<tr>
<td>T3</td>
<td>Dual fuse holder, 1 active, 1 spare (Lafayette 9963372)</td>
</tr>
<tr>
<td>T4</td>
<td>Piece perfboard (0.2 holes on 0.1-in. grid pattern) (Lafayette 19E83584 or equiv.)</td>
</tr>
<tr>
<td>T5</td>
<td>Heat sink for Q1 (Wakefield NF-209)</td>
</tr>
<tr>
<td>T6</td>
<td>Sockets for ICs (Lafayette 47A2152 or equiv.—optional, see text)</td>
</tr>
<tr>
<td>T7</td>
<td>Misc. Transfer letters (Datak or equiv.), bolts, nuts, hardware, push-in terminals and eyelets, pressure sensitive vinyl finishing material (Contac or equiv.), 5-minute curing epoxy, RTV silicone seal, rubber feet, AC line cord, wire, solder, etc.</td>
</tr>
</tbody>
</table>
radius should protrude 5/8-in. beyond the strain distribution washer.

The Interrupter Disc. This disc is made from thin, rigid plastic sheet. If not opaque, spray it with flat black paint after cutting to size and punching holes in it. Punch eight 1/4-in. diameter holes, in the disc, spaced uniformly around the circumference on a radius of 1 3/8-in. Also drill a 5/32-in. hole in the exact center of the disc.

At this point make a jig from two pieces of wood, at least 3/4-in. thick by 3 1/2-in. wide, fastened at right angles. This jig is used to assure proper alignment of the interrupter disc on its bearing disc to the rotor shaft.

Insert a 1 3/4-in. long x 5/32-in. OD, 1/8-in. ID piece of brass tubing into the center hole of the plastic disc so that it protrudes 1/8-in. beyond the outer surface of the interrupter disc. Temporarily fasten the tubing with masking tape to the jig as shown in our photo. Next, epoxy one of the brass discs to the interrupter disc and cement both the perforated plastic interrupter and brass discs to the brass support tubing, spreading the epoxy uniformly around the tubing.

Rotor Shaft. A good time to prepare the rotor shaft is while the epoxy cement for the interrupter disc assembly is curing. It is made from a 3 3/8-in. length of brass tubing 1/4-in. OD. Check it for true-ness and fit in the bearing support tubing previously epoxied in the plastic jar. The rotor must fit inside the bearing tubing snugly, but must still rotate freely in it.

Right side of Indicator unit shows location of J1, exit hole for power cord and mounting screws for T1 and fuse mounting board.

Four lengths of brass tubing 1/8-in. OD by 6-in. long serve as support arms for the four wind cups. These arms are epoxy cemented to the top of the bearing support disc at right angles to one another. One end of each of the rods should be 5/8-in. from the center line of the rotor shaft to leave a clear area so that rotor shaft can be soldered to the disc. For balance it's important that the arms are each separated by 90°. You should use a protractor to double-check this placement.

As soon as epoxy on the interrupter disc assembly has cured, the jig can be freed for proper alignment of the rotor when fastening the rotor shaft to the brass support bearing disc. Solder the brass rotor shaft to the brass disc, employing the jig to ensure ac-
The electronics circuit card is detailed here. Although the photo shows both C2 and C3 the same size, the author recommends C3 a 10 uF, 15v electrolytic.

accurate alignment. Be careful not to bend wind cup mounting rods.

The rotor-shaft assembly and the interrupter-disc assembly are now ready to be mounted in the plastic jar. But first, a lamp holder, to which a pair of leads has been soldered, must be epoxied inside the plastic jar as shown in our illustration. At this stage you should also prepare a mounting board on which the photocell and terminals for the cable between the wind generator and the indicator are installed. The lead wires from the photocell and to the exciter lamp are contained in this cable.

Make the photocell terminal mounting board from a piece of perfboard cut into a truncated pie section having an outside radius of 1½-in. and an inside radius of ¾-in. Overall length of the board should be 1½-in. and it should be ½-in. wide. The photocell is mounted on push-in terminals. Terminal points between the lamp and photocell leads and the lead cable to the indicator are also push-in terminals.

Cement a rain shield, which is a ½-in. length of plastic tubing having a ¾-in. OD x ½-in. ID, to the bottom of the brass-support bearing disc. It should be positioned concentric to the disc, as shown in photo.

Assembly of Pulse Generator. Before final assembly it's best to insert the lamp in its socket and test it to be sure it's working. Once the assembly has been completed it will be difficult to reach the bulb. For this reason we've specified the 50,000-hour long life bulb instead of an electrically interchangeable #47 pilot lamp, which doesn't claim anywhere near that length of life before burnout.

At this stage opaque the housing with dark spray paint if your plastic jar requires it.

Silicone grease, the type used in heatsinking power transistors, will prevent...
“WINDY”

freeze-up when the temperature drops and will also provide lubrication to allow the rotor to turn with little resistance. Place a pea-sized dab on the bearing surface of the support bearing disc. This lubricant should be applied each year before the start of cold weather.

Final Assembly. Insert the rotor assembly into the support bearing tube in generator housing. Now invert the housing and slip the interrupter disc assembly, with its support tubing, over the rotor so that the end of the support tube rides ½-in. below the end of the rotor shaft. Use a single drop of epoxy to cement the support tube to the rotor shaft. If you located the lamp socket correctly within the generator housing, the lamp bulb should clear the interrupter disc by ¼- to ½-in. when the housing is positioned so that the interrupter disc faces down. In this position you should note about ¾-in. up-and-down play in the rotor shaft.

With the photocell mounted in position (see illustration) on its circuit board, cement this assembly inside the generator housing directly below the lamp so that the space between the bottom of the housing and the circuit board is ¾-in. The lead cable will be connected and the cover of the jar fastened in position after the wind cups have been epoxied in position. The reason for this is that the jar can rest on the bench during this assembly if the wire is not in position at this time.

Wind Cups. We made our wind cups from thin, styrene plastic, half spheres, 3 in. in diameter. You may use smaller ones, but no smaller than 2½-in. in diameter. Regardless of the diameter of the wind cups, the center-to-center spacing should not be changed, since this would affect overall calibration of the instrument.

Make a punch by sharpening one end of a scrap of ⅛-in. diameter brass tubing, for punching the holes in the plastic hemispheres, as shown in our photo. The cups should be epoxied to their respective lengths of ⅛-in. OD tubing, positioned as shown in the photos.

Mounting Bracket. The mounting bracket for the completed wind cup pulse generator unit can be made from plastic (which we used), or from metal (iron or aluminum), or from wood.

If you use plastic, make the 90° bend by gently heating the plastic with a small butane torch, being careful not to touch it with the flame. When the plastic softens and becomes pliable, form it over a right-angled block. Keep the material in position over the block until it has cooled down, at which time it will be rigid. If wood is used the bracket is formed by nailing two pieces of wood together at right angles in the shape of the bracket shown in our photos. Metal is formed either in a brake or a bench vise.

Epoxy cement the plastic jar cap to the bracket so that the jar containing the pulse generator and wind cups can be screwed into the jar cap, thus holding it in position. Drill a hole in the bracket to permit the lead wires from the generator assembly to feed out of the jar.

Now The Indicator. The major mechanical construction is complete now and the only remaining assembly work is the indicator unit, which contains the electronics.

We started by trimming a standard 6 x 5 x 4-in. minibox to a 6 x 5 x 3-in. dimension. Since we used aluminum it was easy to pare 1 in. off the depth.

First step is to cut out the large round hole for the meter, and the rectangular holes for the rocker switches, and drill the hole for the pilot lamp, all on the front panel of the major half of the minibox. Also drill mounting holes for the power transformer, fuse holder, input jack, and AC cord on the right-hand side of the box and mounting holes for the circuit board on the left side.

To cut the meter hole and the rectangular switch holes, use a hand nibbler, or, if one isn’t available, drill a series of small holes very close together around the periphery of the main holes. Then knock out the large pieces of metal and file the edges smooth to the exact sizes and shapes required. Deburr all holes before assembly. We used a rectangular 0-1 mA meter we happened to have in the spare-parts box. However, any 0-1 mA having a coil resistance of 100 ohms or less will work. Be sure you have enough room in the cabinet for the size meter you use.

Mount the fuse holder on a 2 x 2½-in. piece of perfboard. The mounting screws for this board should be 4-40s at least ½-in. long so that the board can be held away.

(Continued on page 99)
TREASURE WITCHER

If these headphones give you a buzz, dig where you hear the tone unless you think the ground is bewitched.

HUNTING treasure or water pipes? Then you must, without delay, build our TREASURE WITCHER. With this super-sensitive solid-state instrument you'll greatly improve your odds of finding that long-forgotten treasure that could be only a few feet below the Earth's surface. But, you say, why build the WITCHER?

Simple. With the TREASURE WITCHER you'll be able to locate large metal objects at greater depths than with a metal locator of the beat-frequency type. A large metal chest or a wooden box filled with metal—gold coins, say—will easily be detected several feet beyond the range of Beat-frequency type units. Dig knowing where to dig. If so, read on and learn how you can duplicate this handy treasure finder.

Theory of Operation. No magic, only simple facts are needed to
TREASURE WITCHER

explain the operation of this sensitive metal locator. Two separate units are required in its makeup: a simple transmitter and a receiver, both of which use a loop coil in their tuned circuit. The loop coil also functions as a highly directional antenna.

When the two loop antennas are at right angles to each other, the signal coupled from the transmitter to the receiver is at a minimum and the meter will read zero. But bring a metal object within range of the WITCHER and the transmitted RF field will be distorted. Result is a small amount of RF energy will be reflected to the receiver loop. Picked up and amplified, it will be detected and indicated by the meter and heard on the earphones.

Transmitter Operation. As shown in Fig. 1, transistor Q1 and its associated components, L1, C1, C2, C3, R1, R2, and R3 form an oscillator. The operating frequency, which is in the RF range, is determined by the loop and the three capacitors. The three resistors are used to set the operating bias and output level of the oscillator.

Unijunction transistor Q2 operates as a relaxation oscillator and produces a low-frequency audio tone. This audio signal is coupled to the base of Q1 through C4 and modulates the RF oscillator (Q1). The modulated signal can then be received by a conventional receiver circuit, that extracts the signal that tells where the treasure is.

Receiver Operation. The receiver circuit (Fig. 2) is designed around a very high-gain, linear IC (integrated circuit) that contains three separate high-gain amplifiers, which, when connected in a cascade amplifier configuration, realize a gain of 129 dB.

The first IC amplifier stage is connected together with the tuned circuit as an RF amplifier, which is used to increase the minute signal available at the receiver's loop antenna to a level that can be demodulated into a useful audio signal. The network composed of D2, C7, and R3 performs the demodulation. The demodulated signal appears across gain control potentiometer R3 and is directed to the second amplifier stage through the pot's wiper. This audio signal is once more amplified by the remaining IC amplifier stage. The output is directed to the meter circuit and supplies an audio tone for the earphones, which plug into jack J1.

PARTS LIST FOR TRANSMITTER

| B1—9-V transistor battery (Eveready 216 BP or equiv.) |
| C1—50-pF to 380-pF midget trimmer (Lafayette 34E68337 or equiv.) |
| C2—3300-pF mica capacitor |
| C3—10,000-pF mica capacitor |
| C4, C5—0.1-μF, 200-V tubular capacitor |
| L1—34 turns of #22 enamel wire close wound outside of case |
| Q1—2N2924 transistor (GE) |
| Q2—2N2646 unijunction transistor (Motorola) |
| R1—150,000-ohm, ½-watt resistor |
| R2—39,000-ohm, ½-watt resistor |
| R3—1000-ohm, ½-watt resistor |
| R4—180-ohm, ½-watt resistor |
| R5—47,000-ohm, ½-watt resistor |
| S1—Spst miniature toggle switch (Lafayette 99E61624 or equiv.) |
| 1—6½/10 x 5/2 x 2½-in. plastic case (Allied 42A7886 or equiv.) |
| 1—6½ x 5-in. cover (Allied 42A7888 or equiv.) |
| 1—2½ x ¾-in. perfboard |
| 1—48-in. aluminum conduit |
| 1—Battery holder (Keystone 203P or equiv.) |
| Misc.—Hex spacers, hardware, wing nut, spring, solder, hookup wire, etc. |

Fig. 1. Transmitter schematic details separate unijunction relaxation oscillator modulating npn transistor RF oscillator to produce the tracer's search signal.
Putting It Together. Before beginning, there's one big thing to keep in mind. As in any construction project, it's important to take the necessary time and do the job right the first go-round. This advice may sound oversimplified, but in many cases the cause of a project failure is due to the man behind the gun—the soldering gun, that is—not taking enough time to aim straight. An important point to remember is that no metal locator will work worth a darn if the mechanical construction is sloppy or not completely rigid. This holds true for component mounting and wiring techniques.

The transmitter is a good choice to start with since it will be needed to check and tune the receiver. First step is to take the case and drill and cut all holes so they correspond with those shown in Fig. 3. This must be done with care since the case material will damage easily if abused. After all cutting and drilling have been completed, the loop coil should be wound on the perimeter of the case (see Fig. 4). Following this, tape the coil with a good-quality cloth tape. This will help protect against coil damage during construction and treasure hunting. All components should be mounted and wired to correspond with the transmitter schematic and to match the layout.
as illustrated in our photos.

Transmitter Checkout. The transmitter can be checked to determine if both of the oscillators are working by turning it on near an AM broadcast radio and tuning the radio until you pick up a signal with a steady audio tone. The tone will sound like a high-speed buzz saw and will be easily recognized.

Receiver construction can follow the same basic steps as those for the transmitter, except that all circuit parts are located on Fig. 5A. Photo right shows how transmitter parts are arranged within housing. Note that all components except battery are on perf-board.

the cover instead of the case. Construction is done in this manner for ease of wiring and to take advantage of the structural strength of the case in mounting the receiver to the aluminum conduit.

The receiver will function best if construction matches our model (see Fig. 5). The metal case of the gain control (R3) must be connected to the negative circuit. This can be done by soldering a wire to the control's case and to the circuit ground. As for the loop coil, it should be wound to match the transmitter loop exactly (see Fig. 5B. Photo right details receiver layout on box lid. Two contact connector used to separate receiver from loop for servicing.)
Fig. 3 (above) information for drilling the box to house the transmitter circuit card battery and power switch. Card is raised above bottom by extra nuts on mounting bolts. Complete receiver is mounted on its box cover. Drilling details are shown below. Opposite page (center), Fig. 6 details drilling and mounting details for receiver. Note hinged mount for receiver box. This allows receiver loop to be oriented to null the receiver before starting search.

Fig. 4). A plug and socket are used in the receiver to link the circuit to the loop antenna.

After the receiver has been completed, it's necessary to tune the transmitter to the receiver tuned frequency. To do this, first turn the two units on and place them several feet apart. Next, slowly tune transmitter trimmer capacitor C1 until the receiver's meter indicates a maximum current. If for any reason the transmitter will not tune to
the receiver frequency, then try smaller or larger values for C2. After making a capacitor change carefully re-tune the trimmer until a maximum meter reading is obtained. With the units properly tuned the receiver should be capable of receiving the transmitter at a distance of at least 25 ft.

The WITCHER, when properly tuned, will be operating near 180kHz, but the frequency can vary by as much as 20 kHz without affecting the overall performance of the locator.

**Final Assembly.** The transmitter case is held on to the aluminum conduit with two nuts. As shown in our photo, the conduit goes through the case. The nuts are home-made and can be fabricated by taking a coupling (threaded to fit conduit) and cutting it into two parts. The two nuts must be filed flat so that an equal bearing surface will support the case without causing breakage.

The receiver case is connected to the balance bracket with two 6-32 screws and matching nuts (see Figs. 6 and 7). The receiver hinge is mounted to the opposite side of the case with an 8-32 screw and nut. The receiver is then hinged to the aluminum conduit with a ½-in. 8-32 screw, two flat washers, and a nut. This screw, washer, and nut combination should be tight but with enough play to allow the balance adjustment to be made smoothly.

A 2½-in. 8-32 screw is bolted to the aluminum conduit below the balance bracket and held in place with a washer and nut. A coil spring and flat washer separates the conduit and balance bracket. On top of the bracket is a flat washer and a wing nut which function as a balance adjustment. The handle (see Fig. 7) is made of conduit and should be shaped to match our photos and drawings. A 2¾-in. 8-32 screw, washer, and nut mount the handle to the conduit.

**Putting It to Work.** Turn both units on and set the receiver gain control to mid-posi-

(Continued on page 80)
Modern-day electronics has given man advanced tools to probe the mysteries of the heavens.

Significant and often profound discoveries made with electronic instruments have brought a new age of astronomy—one in which scientists are finding the universe to be stranger, yet far richer in pattern, than they previously suspected.

In 1962, for example, American astronomers launched a rocket, with X-ray sensing equipment aboard, to study the relatively weak rays known to emanate from the sun and, in particular, to find out whether or not they rebound off the moon. (X-rays from space can't be studied at the earth's surface since the atmosphere blocks them out.) To the total surprise of the experimenters, instrument readings radioed back to earth reported a stream of X-rays coming from a distant point in space, a million times stronger than anything that could have been anticipated. It was a little like going out in the back yard to check on a leaking lawn sprinkler and finding a stream of water arching in from blocks away.

Later studies revealed the source of these rays to be a star in the constellation Scorpio. This was the first discovery of an X-ray star—one that puts out a major part of its energy in the form of X-rays rather than light. Since that time, about 30 such stars have been found. Yet, before this unexpected discovery, no one knew or even suspected that these phenomena existed.

Space Broadcasters. In another case, a year later, measurements at the Mount Palomar Observatory indicated that a celestial body, several billions of light-years distant, was emitting rather strong radio waves. In order to reach the earth with such powerful signals, the object would have to be a titanically powerful "broadcaster," millions or even billions of times as strong as anything that the astronomers could then account for.

The Space Clock. Two years ago, startled astronomers at Cambridge University brought in radio signals from space in the form of fantastically regular pulses—far more precise in their timing than any ordinary clock. Since that time, a careful search on the same wavelength...
THE NEW AGE OF ASTRONOMY

band has turned up about a score of these pulsars. It seemed that, for a time, man was at last tuning in on a beacon or signal from intelligent beings separated from earth by two light-years of space. However, earlier this year, scientists visually identified a pulsar on an astronomical photograph. This optically strong pulsar is in the famous Crab Nebula—which is the remains of a supernova, or colossal star explosion—seen on the earth in 1024. The light from the pulsar goes up and down at the same rate as its radio signals, and both are slowing, just perceptibly.

These observations tie in with the current theory of the nature of pulsars. Astronomers now believe they are natural objects—rather than intelligence-generated phenomena. Described as neutron stars, pulsars are the unbelievably dense cores of large stars that collapsed after a supernova. All the atoms in a pulsar are packed together so tightly that a matchbook would weigh millions of tons. The pulsing of its light and radio waves comes from the extremely rapid rotation of the star. The gravity and magnetic field of a neutron star must be billions of times as strong as anything scientists have dealt with before, creating a new and fascinating kind of physics.

The New Tool. All of these discoveries were made with new astronomical tools based on electronics. From the seventeenth century to the early twentieth, the optical telescope had been man’s only means to study the universe. Now, radio, X-ray, infrared and ultraviolet telescopes have added new dimensions to the science of astronomy. They “see” many of the objects and events that are invisible to the optical telescope. Light is just a very thin slice of the electromagnetic energy emitted by hot objects in energy waves—broadcast by waves measured in centimeters and meters to X-rays and gamma rays, whose waves are only as long as a billionth or a trillionth of a centimeter.

Each range of waves requires a different kind of primary sensing instrument to detect it. The radio telescope is simply an ultrasensitive radio receiver. For the infrared instrument, astronomers use a phototube or phototransistor, or other electronic device that puts out electric signals when infrared waves fall on it. Similar electronic sensors are used for the ultraviolet, while X-ray telescopes are based on Geiger counters, electrometers or other electronic devices sensitive to the penetrating, very short waves. However, radio telescopes, the oldest of the new astronomical instruments, are still the principal ones.
At the Listener's End.

Central in a radio telescope is the radio receiver, which must have the lowest possible internal noise to minimize interference with the faint radio signals from space. Many complex radio-reception techniques are employed, including the use of masers, the radio counterparts of lasers. The over-riding objective is to get the highest possible ratio of signal to noise.

But the great antennas of the radio telescopes are probably their trademark to most laymen. These enormous, steerable dishes—bowl-shaped reflectors that can be pointed toward any part of the sky—serve to focus into the receiver a large amount of the incoming energy, which is weak at best. The focusing property of the antenna also allows the astronomer to pinpoint the direction of the signals. They will be at maximum intensity when the antenna axis is pointed directly toward them. The larger the dish the more energy it brings in, and the more precise its direction-finding.

But building a steerable dish larger than about 300 feet across—the size of the largest now operating in the United States—is enormously expensive and difficult. Like the curve of an optical telescope mirror, the curve of the radio telescope dish must preserve its shape to focus at optimal sharpness. Keeping such a great mass of moving metal adequately rigid as it shifts from one orientation to another has seemed so difficult that larger steerable dishes as yet have not been built. (Plans for a 600-ft. dish to be built by the U.S. government apparently have been shelved because of the enormous cost.)

The Big Dish! So, radio astronomers have used other antenna arrangements to get a maximum of energy pickup and direction-finding. This, too, was steered electronically and by the rotation of the earth.

Here's Looking at It.

Even more spectacular are several systems using widely spaced antennas and the interferometer principle: signals picked up at two or more separate points are combined and compared in various ways to increase sensitivity and provide more precise direction-finding.
THE NEW AGE OF ASTRONOMY

Very recently, radio astronomers used this technique of separated antennas to study radio signals from the clouds of oxygen-hydrogen (OH) molecules in space. Atomic theory specifies that these molecules should put out radio waves at certain particular wavelengths. A radiotelescope search of the sky, with the receiver set for those wavelengths, finally brought in astonishingly strong signals. But when the astronomers tried to pinpoint the sources, they found their radio telescopes did not have enough resolution. It was a little like probing for the location of a pin hole with a broomstick.

So, they turned to long-base interferometry, with radio telescopes separated at first by a few miles, then by hundreds of miles and finally by continents. They employed one telescope in California, two in the eastern United States and one in Scandinavia. This all from which a sound is coming, in large part, by comparing the time it arrives at one ear with the time it arrives at the other. A sound to the right arrives at the right ear first. Man's intuitive timing system is good enough to tell how much to the right the

Intertwined spirals NGC5432, 5435

allowed them to define clearly the directions, and thus the widths, of a number of sources of the OH signals, which were tiny on the cosmic scale, extending only a few hundredths of a second of arc in the telescope beam.

Direction-finding was accomplished by comparing precisely the time of the arrival of the signals at the California telescope, say, with the arrival of the same signals in Sweden. The technique has a biological counterpart. Human beings are aware of the direction sound is, down to a minute or two of arc.

It's About Time. Radio astronomers can use this technique because electronic recording systems, combined with one of the ultra-precise atomic "clocks," tell them, to fractions of

Intertwined spirals NGC5432, 5435

Open spiral Messier 74 (NGC628)

Ring Nebula in Lyra

Ring Nebula in Lyra

Whirlpool Galaxy in Canes Venatici

Ring Nebula in Lyra

Open spiral Messier 74 (NGC628)

Saturn
one-millionth of a second, when a signal arrived at each antenna. By comparing the recording made in California with the one made in Sweden, they can determine the direction of the signal with the desired precision.

Recording and timing, carried out with precision down to billionth-of-a-second levels, are essential to a great many other astronomical studies. The exquisitely exact timing of pulsar pulses would not have been apparent without the precise electronic standards of the atomic clock.

Radio astronomers at Maryland Point, Md., even now may be witnessing the birth of planets in a newly evolving solar system somewhere in space. They have detected radio emissions from what seem to be rings of dust and gas circling around a central object. It is believed that this object may be a fledgling star and that the rings may be condensing into its planets.

Both radio and infrared studies are important tools for exploring the very nature of the universe. Astronomers always had been balked in their attempts to see the center of the Milky Way—the galaxy of which reaching earth have been monitored, and they indicate that the center is very thickly populated with stars. Events of extremely high energy are taking place there, as they are in the centers of many of the other galaxies visible in other parts of the universe.

Checking for Hot Spots.

A special telescope was built three years ago to allow California Institute of Technology astronomers to make an infrared map of the sky—to locate all the stars that put out infrared energy above a certain strength. They designed an instrument with a large reflecting mirror and infrared sensing equipment at its focus. This first infrared telescope scanned the sky automatically, driven by motors that moved it back and forth in a regular pattern while a continuous recording was made. One problem in such a scanning is the everpresent background of infrared radiation that comes from nearly every object on the earth and from widespread sources. It tends to obscure the faint infrared beams from the stars.

The astronomers managed to segregate the signals from the stars by giving their telescope a slight, 20-times-per-second wobble, in addition to its slow scanning motion. Whenever an infrared star passed into focus, the telescope responded with a tiny, 20-cycles-per-second signal. The background infrared, being nearly continuous in strength, produced a much more slowly varying, virtually direct-current signal.

By rejecting the back-
ground signals, the astronomers produced a map of the “infrared sky” showing about 6000 stars, roughly equal to the number of stars seen on a clear night with the naked eye.

These primary instruments, including the optical telescope, are backed up by a sophisticated array of secondary electronic instrumentation that defines and refines space signals. Computers, for example, dig signals out of masses of noise that obscure them for ordinary analysis.

Frequency Spotting. Basic to the new astronomy are the devices that reveal the wavelength, make-up and intensity of signals from space. These are the keys to the identification of the chemical makeup, temperature, and other vital facts of celestial bodies beyond the solar system. An ordinary prism crudely breaks a beam of light into its constituent colors (wavelengths). A spectrophotometer system, on the other hand, brings extremely high resolution to the analysis of light and measures strength at each wavelength. Each chemical element, raised to incandescence by the heat of a star, emits its own pattern of wavelengths—its thumbprint in light. The spectrophotometer see those thumbprints.

Rockets and Satellites. Space probes and orbiting satellites are also beginning to find important roles in astronomy. The Orbiting Astronomical Observatory (OAO), launched earlier this year, is radioing back large quantities of data on the ultraviolet radiation from many stars. The OAO carries various kinds of telescopes, all of which can be aimed remotely at stellar targets from earth. The primary value of the OAO is

Old Reliable. Radar is also proving valuable at solar system distances since it takes only 17 minutes to reach the sun and echo back. By bounding signals off the planet Mercury, astronomers have corrected a long-standing error. Photography and the optical telescope had suggested that the planet turns on its axis approximately once every 88 days. Radar echoes now make it certain that its rotation period is actually about 59 days.

The surface makeup of the inner planets has been determined to some extent

Continued on page 98

Galaxy NGC253—a very large inclined spiral

Bubble Nebula Cepheus

Galaxy NGC2903 with small arms
LET DUO-LITE REMOVE THE SHADOW OF DOUBT—
IT TELLS ALL ABOUT SURPLUS OR JUNK BOX TRANSISTORS

TRANSISTORS in your junkbox will turn into usable items when tested on our Duo-Lite. It will tell you whether a transistor under test is shorted, leaky, or open, and whether it's pnp or npn. What's more, it will also give you a beta reading.

Beta, as you may recall, is the current gain of a transistor from the base to the collector when the transistor is connected in the common-emitter configuration. Beta is perhaps the most significant parameter of a transistor and is used, for example, in determining overall stage gain. The standard notation for beta is hfe.

Circuit Operation. As shown in Fig. 1, lamp L2, resistor R3, switches S2 and S3, and battery B1 form a simple series circuit. Current flow in that circuit can be determined by using Ohm's Law (I = E/R). E in this case is the battery voltage (4.5 V) and R here is the sum of the individual resistances of L2 (33 ohms) and R3 (43

by George A. Ellson, W7EKH
Duo-Lite Q Checker

Therefore I (circuit current) is 4.5/76 or roughly 60 mA.

The remaining part of the circuit consisting of switches S1, S2, and S3; resistors R1 and R2; lamp I1; battery B1; and the transistor under test is a common emitter amplifier. Transistors to be checked are plugged into socket S01 or connected to the alligator clip leads. The base current is controlled by adjusting R1 (S1 closed). This varies collector current and therefore the intensity of I1—which can be made equal to I2. When this occurs, 60 mA is flowing through the collector circuit. If at this point, we could determine the base current, we'd be able to determine beta as the quotient of Ic/Is—where Ic and Is refer to the collector and base currents respectively. The base current for any position of R1 is tabulated in the calibration procedure.

The circuit determines a shorted transistor by the presence of a very high collector current and therefore a brilliant I1 with S1 open (zero base current). Leaky transistors are also spotted in this way, but the collector current is much less.

Switch S3 reverse biases the collector junction, which is a necessary condition it
we want to know whether a transistor is open, pnp or npn, and what its beta is. Open transistors show no collector current regardless of the base current. With S1 pressed therefore, lamp II remains dark for all settings of R1.

**Construction.** As shown in our photo, all parts are mounted in a 6½ x 3½ x 2½-in. interlocking chassis. Lay out all parts on the surface of the box and mark their locations. Drill and punch all holes. Mount the plastic window first, using 4-40 hardware. Next, install all remaining parts. The L bracket for separating the window into two sections is formed from a piece of 2 x 3-in. scrap aluminum. The battery holder is mounted on a 7 x 1-in. piece of scrap aluminum. Place a piece of electrician’s tape at each end of the chassis before mounting the battery holder to prevent accidental grounding. The dial is made of paper cemented to the chassis and shellacked after calibration.

**Beta Calibration.** To start with you'll need a transistor that you know to be good (not shorted, leaky, or open). Plug it into the socket or attach it to the clip leads and connect a VTVM or VOM across R2. The higher the resistance of the meter the less loading there will be of R2 (and the more accurate the reading), so a VTVM is preferred.

With R1 set at minimum, press S1 and measure ER2. Base current (Ib) can be calculated using Ohm’s law; the equation in this instance is Iu = ER2/R2. Ib can be readily found since R2 and ER2 are known quantities. Assuming a 60-mA collector current, beta can be calculated by using the equation beta = Ic/Ib. Mark this value of beta on the dial next to the knob pointer fitted onto R1. Repeat this procedure for as many different beta readings as you desire spaced around the dial. The author calibrated his dial with 15 positions from minimum to maximum but there's no reason why you couldn’t use more or less.

**Check Out.** Plug in your transistor to be tested or connect to the alligator clip leads. Refer to a manual to determine the positions of the collector, emitter, and base of your transistor so that you can properly connect it in the circuit.

Turn on the Duo-Lite. If II glows brightly, the transistor is shorted. A dim glow indicates leakage. A shorted transistor is of no value to you but a leaky one can often be used in switching circuits. If the transistor isn't shorted or leaky, you should next check for opens. Set R1 to minimum and press S1 using first one and then the other position of S3. If II remains unlighted in both positions of S3, the transistor is open. Open transistors can be used as diodes (one junction is probably good—surprise, heh?).

If the transistor isn't shorted or open, now is the time to determine its makeup (pnp or npn). Refer back to the test for opens and note that in one of the positions of S3, lamp II is lit. This position of S3 is marked either pnp or npn (see photo), and voila, that's what your transistor is. Now you can determine beta by pressing S1 and rotating R1 until II and I2 are of equal brilliance. Beta is read off the previously calibrated dial.

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**Bend tabs at each end of 7 X 1-in. bracket to form full length shelf to hold 3 penlite cells.**

**From rear, RH tab 1 X 9/16-in. LH tab 1 X 3/4-in.**
Those little clip-on calendars that wrap around a watchband are mighty handy gadgets. But telling the day of the month doesn't need to be their only function in life. They also can be put to work to help keep track of at least two time zones.

Active people, such as radio operators, pilots, and traveling businessmen, often need to know the time of day simultaneously in two locations. One of those wristwatch calendars can be easily modified to handle this assignment with ease.

Greenwich Mean Time is frequently used by ham operators and by pilots, since it serves as a universal time recognized in all parts of the world. Nor is it affected by local time zones and changes from standard to daylight saving time. Businessmen also need such convenience. But they generally want to know the time at their home office, plus some distant location, such as a district office or an important customer's plant.

Two On One. Our double-timing watchband can provide this convenience without the necessity of carrying two watches, or of buying a high-priced watch with an adjustable outer dial bezel for the second time zone. With this modified watchband, any wristwatch serves to tell the wearer the time in two places—any two places in the world!

Heart of the system is a simple chart which you affix over an outdated clip-on wrist calendar. The chart compares local time with GMT (or with any other time zone you may wish to use). You use the watch normally for local time, but refer to the chart to convert local time instantly to GMT, and vice versa.

The chart shown in the photos was prepared for use in the Mountain Standard

(Continued on page 64)
Our 2-Meter Converter Puts your BCB Receiver On the Beam

By Charles Green W6FFQ

WHY not become part of the friendly round tables, net activities, and leisurely conversations prevalent on the 2-Meter ham band throughout the U.S.? This band, extending from 144 to 148 MHz, is quite different in character from the lower-frequency ham bands with their fast QSOs and heavy QRM.

The MARS and CAP nets at the edges of the band and the Civil Defense nets within the band make interesting listening. Traffic nets pass messages from other bands for local delivery and experimental transmissions of all kinds are common in it.

You really don't have to spend a fortune for a receiver in order to join the listeners on the 2-Meter band. Our SemiPro, a 2-tube converter used in conjunction with a BCB receiver, converts the 2-Meter signals for reception at the high end of the broadcast band.

Circuity. In reality, SemiPro is a conventional superheterodyne front end, consisting of an RF amplifier, an oscillator, and a mixer: its RF output signal at 1650 kHz will be amplified and detected by a standard BCB receiver it must be connected to. As a matter of fact, if your BCB receiver is a super (as are most modern BCB receivers), you wind up with a double-conversion 2-Meter superhet. Double conversion achieves the higher gain and selectivity normally associated only with high-performance, professional communications equipment. This accounts for SemiPro's high performance on 2-Meters when coupled to a superhet BCB receiver.

How It Works. The 2-Meter signals picked up on the antenna are fed through J1 to the
SemiPro

primary of L1, a broadband coil. Its secondary feeds the cathode of V1, a grounded-grid amplifier.

These amplified signals are tuned by L2 and C3A and coupled to the grid of V2A mixer stage via R2 and C4. The other half of V2 (V2B), the oscillator stage, is tuned by L4 and C3C to produce an RF output signal that is always 1650 kHz above the incoming signal frequency. The oscillator (V2B) output is coupled to the mixer (V2A) grid by C5 and the resulting heterodyne signal output is fed to the tuned circuit comprised of L3 and C7 and thence via J2 to a BCB receiver that has been tuned to 1650 kHz.

A built-in power supply furnishes both heater and B+ voltages for operating the converter.

Building the SemiPro. Because this is a high-frequency circuit, wiring and layout are critical. Therefore we suggest you follow our layout as shown in our photos.

SemiPro is built on a 7 x 7 x 2-in. aluminum chassis with a 3½ x 4½-in. heavy aluminum panel for mounting the dial, centered on the top front edge. Mount the dial to the panel and temporarily couple the ganged tuning capacitor (C3A, C3C) to it with an insulated flexible-shaft coupling. Cut the tuning gang shaft so that when this connecting lug. Bend these lugs so that they are centered over the holes, to keep connecting leads underneath the chassis as short as possible.

Locate the rest of the parts, keeping the same relative spacing between them, especially the tube sockets and the tuning capacitor, as shown in our photos. Coil L3 is mounted inside the shield can. Leads to it and capacitors C7, C8, and C9 are connected through a 7/8-in. hole in the chassis directly under the shield can.

Mount coils L1, L2, and L4 and associated resistors and capacitors around the sockets for V1 and V2 so that leads will be as short as possible. Connect center leads of sockets for V1 and V2 to chassis ground. Ground C6 and C12 to center post of V1 and be sure ground lugs are placed between mounting bushings and chassis when fastening L1, L2, and L3 to ensure short ground leads.

Remove tuning slug originally supplied...
APRIL 1970

PARTS LISTS FOR SEMIPRO

C1, C6, C12, C14—1000-pF, 500-V ceramic disc capacitor
C2, C10—10-pF, 500-V, npo ceramic disc capacitor
C3A/C3B/C3C/C3D with trimmer capacitors—6.6 to 23 pF, two-gang variable capacitor (J.W. Miller 1461-2, see text for modification)
C4, C11—27-pF, 500-V ceramic disc capacitor
C5—Gimmick capacitor (see text)
C13A, C13B—15-50 uF, 150-V tubular electrolytic capacitor
D1—1N2071 silicon diode, 600 PIV, 750 mA
F1—1/2-A, 250-V fuse type 3AG (solder pigtails to ends for mounting and connecting)
J1, J2—RCA type phono jack (Switchcraft 3501F)
L1—0.108 mH to 0.180 mH RF coil (J.W. Miller 20A157RB1)
L2, L4—0.88 mH to 1.20 mH RF coil (J.W. Miller 20A107RB1) (J.W. Miller 30-202-5 brass tuning slug to modify L2—see text)
L3—Oscillator coil (J.W. Miller A-5496-C mounted inside J.W. Miller S-33 shield)
P1, P2—RCA type phono plug (Switchcraft 3501M)
R1—330-ohm, 1/2-watt resistor
R2, R5—12-ohm, 1/2-watt resistor
R3—1,000,000-ohm, 1/2-watt resistor
R4—22,000-ohm, 1/2-watt resistor
R6—47,000-ohm, 1/2-watt resistor
R7—2700-ohm, 1/2-watt resistor
R8—1200-ohm, 2-watt resistor
RFC—1.72 mH RF choke (J.W. Miller RFC 144)
S1—Spst slide switch (Continental-Wirt GF1123 or equiv.)
T1—Power transformer: primary 117-V, 50-60 Hz, secondaries 125V @ 15 mA and 6.3V @ 0.6A (Stancor PS8415 or equiv.)
V1—Type 6AB4 tube
V2—Type 6KE8 tube
V2A—Type 6KE8 tube
1—7 x 7 x 2-in, aluminum chassis (Bud AC405 or equiv.)
1—3/4 x 4 1/2 x 1-in, sheet aluminum with 1-in. mounting flange for mounting dial to chassis (see text and photos)
1—Flexible coupling (Miller 39001 or equiv.)
1—7-pin miniature tube socket with mounting plate (Cinch-Jones 7EB or equiv.)
1—9-pin miniature tube socket, with mounting plate (Cinch-Jones 9EB or equiv.)
1—Vernier dial (J.W. Miller MD-4 or equiv.)
Misc.—Perfboard, push-in terminals, ground lugs, tie strips, rubber grommets, plastic spaghetti tubing, hookup wire, solder, hardware, press-on letters (Datak or equiv.) RG-59/u, coax cable, etc.

SemiPro uses just two tubes to make it a complete superhet front end. One, (V1-type 6AB4) is the RF amplifier, and the second, (V2A, V2B-type 6KE8) is a pentode and a triode in one envelope. Gimmick capacitor couples V2B oscillator output to mixer, V2A. RF output is 1650 kHz to feed BCB receiver.
with L2 and replace it with a brass slug (J. W. Miller 30-202-5). Primary for L1 is made by a single loop of wire wound around the coil, with one end connected to ground lug and the other directly to J1 (make as direct as possible).

Gimmick capacitor C5 is made by twisting two short lengths of hook-up wire into three twists and connecting one end of each lead to pins 2 and 9 of V2 respectively. The other ends of these leads are not connected. Capacitors C2 and C10 are connected to C3A and C3C tuning capacitor by short lengths of insulated bus wire.

With the exception of T1 and C13A and C13B, the balance of the power-supply components are fastened to a 1¾ x 2½-in. piece of perfboard which is mounted under the chassis adjacent to T1. Transformer T1 is mounted on the top left hand (from the rear) corner of the chassis with leads fed through grommets to the rest of the power-supply components inside the chassis pan. Keep heater leads from T1 and B+ leads from power supply as far away from the RF circuits as possible.

A short length of RG-59/U coaxial cable is used to connect V2A plate to L3. Be sure the shield is grounded to the chassis at both ends of the cable.

Alignment. Once you have double-checked the wiring for accuracy and have allowed the tubes and other components to warm up, you are ready to align your SemiPro for optimum results. A short length of RG-59/U coax cable is used between J2 (output jack) of the converter and the antenna and ground terminals of your BCB to interconnect the two. If your BCB receiver doesn't have antenna and ground terminals but does have a ferrite rod antenna, loop several turns of hook-up wire connected to the center contact of J2. If by chance your BCB receiver is an AC/DC set of the so-called "hot chassis" variety, make certain that there's no direct electrical connection between the two chassis to avoid placing the chassis of the converter at a dangerous electrical potential. Best way to prevent this is to place a small capacitor (0.01 µF) in series with the grounding lead.

Tune the BCB receiver to a clear frequency at or near 1650 kHz. If the receiver doesn't tune that high, pick a clear spot as close as possible to the high-frequency end of its tuning range. You'll need a signal generator to be sure the converter's RF output is properly tuned to the high-frequency spot used on the BCB receiver. Connect the signal generator to the stator lug of C3A (mixer tuning capacitor) and chassis ground of the SemiPro. Adjust L3 of the converter for maximum signal output from the BCB receiver.

Once this has been done, disconnect the signal generator from C3A and connect it to J1 on the converter. Set trimmer capacitors C3B and C3D of the ganged variable capacitor on the converter to minimum capacity (screws backed out nearly full length) and turn the dial of the SemiPro to not quite full capacity (at 144 MHz on dial in photo). Set the signal generator for a 144-MHz modulated signal output and then adjust L2 and L4 tuning slugs for maximum signal output on the BCB receiver.

Next, turn dial on SemiPro to almost minimum capacity of tuning gang C3A/C3C (148 MHz on dial in photo), set the signal generator for a modulated output signal of 148 MHz, and adjust trimmer capacitors C3B and C3D for maximum output on the receiver. Repeat these adjustments to be certain optimum alignment has been reached.

At this point we calibrated the dial and marked it with press-on letters. We set the signal generator at each of the frequencies marked on the dial and noted the spot where they tuned to maximum on the SemiPro dial. Since the MARS and CAPS nets are at the extreme edges of the band we calibrated (Continued on page 100)
"The stars can do anything," purred Madame LaZongle. And Lo! if they didn’t for a chicken-necked ham name of Horace Twipple!

SHAKESPEARE gave a perfect description of Horace Twipple when he wrote, There are stranger people roaming around this Earth than you have ever dreamed of, Horatio.

Horace was a thin, middle-aged ham operator with a neck like a chicken’s and a head as smooth as an egg. He had studied electronics until he could assemble a computer blindfolded. Yet every time he landed a job he fouled something up, usually within a week.

He went down to Guaymas, Mexico to take charge of the radar tracking station there and cover orbital flights. After four days on the job he sent out a Red Alert. Horace had picked up signals coming from a fleet of Russian submarines heading up the coast of Baja California toward Los Angeles.

After Washington, the Air Force and the Navy were alerted, and the Hot Line to Moscow activated, it was discovered that the signals were coming from radio transmitters and sonar beeping devices fastened to the backs of gray whales. San Diego scientists were determined to snoop on gray whales to find out where they go.

Being unpopular with the Government after this incident, Horace joined the sound division of the great C.S.B. television network as an operator of a portable overhead mike boom for TV shows. A step down, but a man has to eat.

Disaster struck the second week on this job. He was admiring the shapely legs of a chorus girl during the rehearsal of a musical special and in place of following
Horace Twipple

the star, he absentmindedly swung his long mike-boom arm in the wrong direction. He hit the producer of the show on the head and knocked him cold as a halibut. The man was a nephew of a C.S.B. vice-president.

When he came to his senses, the producer rose to his feet. “You’re fired!” he shouted at Horace in icy fury. “Get down off that stage! Get out of this studio! Go and get lost, you stupid idiot!”

Horace climbed down and walked over to face the irate man.

“Listen, Mr. Pidmore,” he said, “just because you happen to be the nephew of the president of this lousy company you think you’re sitting high up on the pole, don’t you? Well, let me tell you something. No man calls Horace Twipple a stupid idiot. I’m fired, am I? Okay. The day will come when you will also be fired because I am going to buy the C.S.B. Company—lock, stock, and barrel.”

That night in his ham shack he asked his fellow hams how they would go about buying a giant television network.

“Consult an astrologer,” replied a man from Moosebutt, Canada. “The stars never lie. They told me that when Pluto crosses Venus is the time for me to look for a job. That doesn’t happen until 1978 so my old lady is supporting me until then.”

“Think of some way to bring radio back,” advised a man from the Windy City. “TV is a habit of the public. Only way to break a habit is to form a stronger one. Think up something sensational to swing the people back to radio. Then you’ll be able to buy C.S.B. for peanut shells.”

After eating breakfast the next morning, Horace went out to Coney Island and walked into the booth of Madame La Zongle, Horoscopes, Tarot Card Readings and Hot Tips for the Racetracks. After giving her his day of birth and the time, the Madame quickly came up with his horoscope.

“You are a Taurus, the Bull,” she told Horace. “You were born when the Moon was in conjunction with Neptune in the House of Pisces, the Fishes. Neptune is water . . . ah, you work on a fishing boat?”

“No, I’m not working anywhere,” said Horace. “But I have a serious problem concerning television. Could the stars tell me what to do about solving it . . . like thinking up brilliant ideas?”

“Of course. The stars can do anything, my good man. Television, you say? Ah yes, I see Plato, the Hound, whose element is air, on the ascendent. Pluto the Hound symbolizes sniffing out something. My dear man, you are going to invent something spectacular. You may be the reincarnation of Galileo,” she said, fluttering her false eyelashes at Horace hopefully. “Being a Taurus, your element is earth. Therefore you must seek the answer to your problem first in the earth, then in the sky. That will be ten dollars.”

Horace returned to New York feeling disappointed. How was he going to find the answer in the earth? Maybe she meant he should go to Pittsburgh and get a job in the coal mines. He decided to stop in the Pussy-cat Club for a drink.

Over a double vodka he glanced at his neighbor, who wore a long, thick beard.

“Say, that’s a pretty good display of wool you’re wearing,” he said. “Are you trying to close up the Gillette Company?”

“No, I’m an archaeologist,” said the man. “I’ve just returned from Egypt and I’ve got to give a talk tonight at the Explorer’s Club on the carbon-14 method of testing ancient relics so I stopped in here to fortify my nervous system with a little ambrosia.”

“Carbon 14? Does that have something to do with radioactivity?”

“Right! All living things are radioactive. Cosmic radiation produces neutrons that give off radioactive carbon dioxide in the air. Plants live on carbon dioxide and become radioactive. Animals live on plants and become radioactive. There is a lot of radioactivity around. All living things maintain constant radioactivity during life. At death, it diminishes at a regular rate. By measuring the amount of activity remaining in any item we can determine its age. For example, we tested a human hair from an Egyptian mummy and found that it was 5800 years old,” the man said calmly.

“Man, you have the life. Traveling around digging up the earth to find old junk. Wait a minute! Earth! The Madame said look in the earth first. Say, the stars are getting right on the job. Tell me more about this carbon 14. Is there any in the sky?”

“There is a dense mass of cosmic ray neutrons in the higher layer of our atmosphere, at 40,000 feet. They are caused by

(Continued on page 79)
Build our six-buck preamp in one evening and convert your so-so SWL receiver into a red-hot number.

By Edward A. Morris, WA2VLU

CHANCES are, if your general-coverage SWL or ham receiver cost much under $100.00, it’s lacking sufficient RF gain. Fact is, many of the more inexpensive receivers lack an RF stage altogether! If you’re ever going to get out of the novice league when it comes to pulling in the rare ones, you’ll have to correct the situation. You could go out and plunk down $250.00 to $600.00 for an all-band, do-everything, super-deluxe receiver. Thing is, there aren’t too many of us who can afford to go that route.

As you may suspect by now, there’s another answer—our Station Blazer. Station Blazer is a wide bandwidth RF amplifier that provides 12-15 dB of signal gain. That’s an increase of about two S units. Station Blazer covers 3 to 30 MHz in one giant step. No tuning or signal peaking is necessary and the only control is an on/off switch.

All that signal helping gain is provided by a mere handful of parts. Total cost should run under $6.00, and that’s for a fancy version. Construction is simple and goes quickly. It’s a one-evening project.
Station BLAZER

Schematic diagram shows how simple our Station Blazer is to build and how few components can be put together to make a very efficient preamp thanks to the FET.

**PARTS LIST FOR STATION BLAZER**

- **B1** - 9-V battery (Eveready 216BP or equiv.)
- **C1, C4** - 100-pF, 25-VDC disc ceramic capacitor
- **C2, C3** - 0.01 μF, 25-VDC disc ceramic capacitor
- **D1, D2** - 1N270 diode (RCA)
- **L1** - See text
- **L2** - 2.5-mH choke (National R-50-2.5 or equiv.)
- **Q1** - HEP 802 field-effect transistor (Motorola)
- **R1** - 220-ohm, ½-watt resistor
- **S1** - Spst miniature toggle switch (Lafayette 99E61624 or equiv.)
- **TBI** - 5-terminal screw terminal board

**INPUT**

1—See text
2—1N270
3—1N270

**OUTPUT**

- 1—¾-in. dia. x 1-in. long ferrite rod taken from a ferri-loopstick antenna (Lafayette 32E82019 or equiv.—see text)
- 2—¾ x 3 x 2½-in. interlocking chassis (LMB-135 or equiv.)
- 3—Battery holder made from ½ x 1¾-in. scrap aluminum
- 4—Circuit board, copper clad on one side
- Misc.—Push-in terminals, vinyl covering material, rubber feet, hardware, solder, hook-up wire, RG8/u coaxial cable, etc.

How It Works. RF signals from the antenna are coupled from terminal 1 of terminal strip TBI to the gate of field-effect transistor Q1 via coupling capacitor C1 (see Fig. 1). Coil L1 provides a DC return path to ground for the gate but blocks RF.

Transistor Q1 is biased for normal amplifier operation by resistor R1 in the source ground leg of the circuit. Capacitor C2 by-passes R1, preventing degeneration and loss of amplifier gain. The amplified signals appear at the drain of the transistor and are coupled to terminal 5 of TBI by capacitor C4.

Diodes D1 and D2 are connected across the input. Normally they don't affect circuit operation. They do come into action, how-

You can see how well the Station Blazer's laid out, with all components mounted on one sided copper foil board. Good HF wiring practices must be used for it to work.

You can see that all it takes to run our Station Blazer is just one control—the power switch on the front panel turns it on or off. It's easy to build and fun to use.
ever, to protect the FET from high voltages generated by lightning and static discharges as well as high-power transmitters located nearby. They conduct only on high-level inputs, grounding the signal, and thus protecting the FET from possible damage.

Begin construction by marking the chassis with the mounting positions of switch S1, terminal strip TB1, the circuit board and rubber feet (see Figs. 2 and 3). Once the parts layout has been determined, spot and center punch the holes to be drilled, then drill and deburr all holes. The cutout for the terminal strip is most easily made with a hand nibbler. With the necessary holes drilled and all other mechanical work on the case completed, finishing the case is the next step. The author's model was covered with a contact adhesive vinyl material. This type of material is widely available in a variety of colors and patterns.

**Electrical Construction.** The exact electrical layout isn't critical, as long as proper hf layout and wiring techniques are kept in mind. Remember the FET has lots and lots of gain. Couple this with its high input impedance, and you can see where sloppy layout and wiring can get you in trouble! Poorly wired, Station Blazer will act more like an oscillator than an amplifier, and this we can do without.

The general component layout can be determined from our photos. Most of the parts are mounted on a copper-clad board. Take care to use short, direct leads. Note that coils L1 and L2 are mounted at right angles to one another. This is done to reduce inductive coupling between input and output. Further isolation is provided by shielding the input from the output circuit with a section of copper-clad board.

With the exception of the lead from Q1's gate to L1, all wiring is carried out on the component side of the board. Two strips, along opposite edges of the board, should be removed to provide insulated areas for push-in terminals and mounting nuts. To remove the strips score the material with a hobby knife and pull off the unwanted copper areas.

Transistor Q1 is soldered directly into the circuit. Precautions should be taken to prevent Q1 from damage due to excessive heat while soldering. This means that your old 250-watt lead melter is definitely out! Use a small (under 50 watts) well-tinned iron, and complete the job as quickly as possible. The source and drain leads are interchangeable. The gate leads, however, isn't interchangeable with any of the other leads and must go to L1 and C1.

Coil L1 is home-brew. Start with a 3/8 x 5-in. ferri-loopstick antenna (see Parts List) and unwind the turns. Cut off a 1-in. long section of rod and wind it with 40 turns of #26 PE wire closewound. Cement the turns.
Station BLAZER

in place with Q-dope or Duco cement. The low-frequency coverage of Station Blazer can be extended down to 0.5 MHz by winding L1 with 150 turns on a 1½-in. long ferrite rod, closewound in 3 layers. Some loss of gain at the higher frequencies will result, however.

After the electronic card has been wired, check it against the schematic for possible errors and shorts. Mount the card in the case using 4-40 x ½-in. screws. Space the card about 3/8 in. off the chassis, using additional nuts under the board on the screws. Complete the few final connection between the card and the input/output terminals, battery B1, and switch S1.

Using It. All that's left to do is to connect your receiver's input terminals to Station Blazer's output and your antenna to the input. Station Blazer is connected to your receiver using a short length (under 3 ft.) of RG-8/U coaxial cable.

For best results, a good ground is a necessity. However, when connecting ground wires to systems containing an AC/DC receiver you must use special precaution because a lethal shock hazard is present. The best procedure to follow is to first isolate the receiver from the power line using a 1:1 transformer.

All set? Snap in the 9-V battery and turn your Station Blazer on. Never knew there were so many signals, eh? Gain improvement is most noticeable on weak signals, about S1 or so. Boosted to a more respectable S3, these stations are much more readable. Best of all, signals you never even suspected of existing before can now be copied and logged.

Happy DXing!

Doubletimer
Continued from page 54

Time zone, and goes like this:

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However, it can be modified for use in any time zone you prefer. The horizontal lines following the letter L indicate hours in local time. The lines following the D (for day) indicate GMT when local time is between 6 a.m. and 6 p.m. And, the lines following N (for night) indicate GMT hours when local time is between 6 p.m. and 6 a.m.

The chart was typewritten on a white card, then copied with a camera using a close-up lens. A print was made to the exact size of a wristwatch calendar, and glued to an old calendar with epoxy cement.

After the cement dried, the edges were beveled with fine sandpaper, then two coats of varnish applied to protect the surface of the chart from wear and smudges.

Using It. With such a chart attached to your watchband, use it this way:

√ To convert local time to GMT, first look at the watch dial reading local time. Let's say it reads 8:32 and it's in the evening. Locate 8 in an L line on the chart. You see it's opposite 3 in the N line and 15 in the D line. Since it's night time, disregard the D line and use the N line. This tells you that 8 p.m. local time (in the Mountain Standard Time zone, for which this chart was prepared) is 0300 GMT. Add to this the number of minutes shown on your watch dial and you have 0332 GMT.

√ To convert GMT to local time. Suppose a ham in Europe told you he'd be on the air at 1700 hours GMT, and you want to listen for him. Look at the chart for 17. You see it's opposite 10 and in the D line. This tells you local time will be 10 o'clock in the daytime, or 10 a.m.

What could be simpler?

For use in other time zones, set up your chart this way: 0000 GMT equals 8 p.m. in EDT, 7 p.m. in EST and CDT, 6 p.m. in CST and MDT, 5 p.m. in PDT, and 4 p.m. in PST. Once you have this key hour filled in, the rest of the chart follows logically.

If at first glance the chart seems complicated, never fear. After you've used it a few times, you'll marvel at how simple... and handy... it is to use.

Now, with any inexpensive watch, you can carry GMT (or some other time zone) with you all the time. And of course if you still want to know the day of the month, you can wear a conventional clip-on calendar for the current month, plus your GMT conversion chart on a separate clip-on.

Sure beats carrying a sun-dial around, doesn't it?
TAKEN at face value (or rather at front-panel value) the Fisher 500TX looks like any other feature-packed AM/FM-stereo receiver, only more so. It has all of the usual controls plus a section of the front panel titled: TUNE-O-MATIC, which looks like a flight-control panel from the latest jet. As a matter of fact, TUNE-O-MATIC is just one of the many extra features resulting from Fisher’s use of a complex FM front end incorporating an unique electronic tuning system.

You name a desirable feature and the 500TX in all probability has it, since it contains more features than one normally expects from a commercially-built unit.

Most interesting, to our way of thinking, is the electronic tuning scheme for the FM band, a completely new tuning system not previously available in consumer equipment. It’s interesting because of the total absence of a ganged variable tuning capacitor for the FM portion of the receiver.

In addition to electronic tuning, Fisher has also incorporated automatic signal search (or AUTO-SCAN, as Fisher names it), as well as manual tuning from the front panel, plus complete, foolproof continuous remote tuning, and pushbutton selection of four of your favorite FM stations.

How ET Works. Electronic tuning (ET) is uncomplicated and is accomplished by using varactor diodes in place of the conventional tuning capacitor. A varactor diode is a special type of diode whose capacitance across the anode and cathode leads, under reversed polarity conditions, varies with the applied DC voltage.

In the 500TX, Fisher uses a somewhat different three-terminal varactor diode. It is, actually, a twin back-to-back diode that provides for a greater than usual capacitance range along with temperature stabilization. The FM front end employs five varactors, one for input and two for output tuning of the RF amplifier, one for tuning the oscillator, and one providing AFC correction. In addition, FETs are used in the RF amplifier, mixer and IF amplifier, which also includes a crystal filter.

The AM portion of the 500TX is quite conventional, employing the usual ganged variable tuning capacitor. A potentiometer coupled to, and mounted on the rear of the AM tuning gang, provides the variable voltage for electronic tuning of the FM portion of the receiver.

Push a switch and the voltage control is switched to any one of four preset potentiometers to select any of your four favorite FM stations. These potentiometers are mounted so that their adjustment is in-
Lab Check

Dedicated by vertical positioning of slide levers mounted behind four slots in the receiver's front panel. These slots have frequency calibration indications for the preset tuning.

Another pushbutton actuates the auto-scan which automatically sweeps over the band at a slow rate, thus allowing the listener to hear each receivable signal in the band. This circuit consists of 18 transistors plus an integrated circuit (IC). Or, you can push a sixth pushbutton and the Auto Scan selects the next station above or below the last station selected. The electronic tuning auto-

accurate within 2 MHz. Obviously the meter calibration should be improved.

Additional features. Other features of the 500TX include: a) 65-W rms output into 8 ohms impedance for each channel; b) provision for connecting main and remote speakers as well as a center channel mono output at speaker level and outputs for phones and a tape recorder. Want a reverb? Input and output connections for a reverb device are prewired on the rear chassis panel. Also on this rear panel are connections for phono input with high- and low-gain selector switch, auxiliary, recorder, tape.

(Continued on page 102)
Who's Minding the Store?

What is the purpose—or purposes—of ham radio? Do you know? Can you jot down a list of them?

I used to think I could. But with the events of the past year or so, I'm beginning to wonder if any of us can.

Developments ... or disappointments ... in the status and future of ham radio should give all of us something serious to think about.

We're all accustomed to change in hamming habits and principles, or at least we should be. Yet some of the changes being aimed at us from the hallowed halls of Washington, D.C. don't look very healthy for hamming in the future, I fear.

Look at the Facts. Let's take a look at the record, review some recent events, and see where these events seem to be leading us.

First, let's turn the calendar back just a few years and recall the big furor raised over the issue that became known as incentive licensing. This all began with some strong hints by influential officials at the FCC who said ham radio in the U.S. was deteriorating in quality, and that something should be done about it so the hams could present a strong case at the next international frequency allocations conference. They warned that hams would have to demonstrate through their actions that they were seriously interested in radio communications as a constructive activity, rather than just a plaything.

With this as a background, the American Radio Relay League (ARRL) proposed a revamping of the license requirements. To get full use of all ham bands, a feller or gal would have to upgrade him or herself by passing a stricter exam. This led to dividing up the bands into General, Advanced, and Extra Class segments.

A lot of tempers were lost in the verbal battle that ranged across the country. Eventually, the basic idea was written into the regs ... except that the Friendly Candy Company split up the bands in a much more complicated way than had been proposed.

Up ... And Down. Despite this needless complexity of the regs, the general result has seemed to be beneficial for ham radio. Certainly a lot more hams have taken—and passed—the higher-class license exams than did so when the Extra Class License was merely a hollow no benefit achievement.

Most observers have said some of the slopiness which was becoming commonplace on the bands has been cleaned up in the band segments reserved for the higher-class operators. This gives validity to the original theory of incentive licensing—that the result would be an improvement in technical knowledge and in operating ability.

Thing is, just when the idea seemed to be paying off ... with at least a part of the ham population proving they really wanted to improve themselves ... along comes the Friendly Candy Company with some more changes and proposed changes. Coupled with them is a profound lack of really progressive spirit that may well cancel out the benefits we might have reaped from incentive licensing.

Getting down to the nitty-gritty, the Feds have partly cancelled out their original incentive licensing regulations by deciding that some of the restricted frequencies which were supposed to go into effect in the second year of the system won't go into effect after all. In other words, they set up an incentive system, gave it only a year's trial.

(Continued on page 101)
NRI "hands-on" training in TV-Radio, Electronics can give you as much as 2 years of on-the-job experience.

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NRI lab equipment is designed from chassis up for effective, fascinating training — not for entertainment. The fact that end results are usable, quality products is a bonus. In Communications, for example, you build and analyze, stage by stage, your own 25-watt phone/cw transmitter. It's suitable for use on the 80-meter amateur band, if you have an interest in ham radio. In TV-Radio Servicing your practical training gives you your choice of monochrome or color TV sets. All training equipment is included in the low tuition — you pay nothing extra. Discover for yourself the ease, excitement and value of NRI training. Mail postage-free card today for new NRI Catalog . . . or use the coupon below. No obligation. No salesman will call on you. NATIONAL RADIO INSTITUTE, Washington, D.C. 20016.

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ACCRREDITED MEMBER NATIONAL HOME STUDY COUNCIL

APRIL/MAY 1970
Photos on this page show interiors and exterior views of the new Metro Mexico. Note the subway stop above with its symbols for Indios who haven't learned to read as yet. Bottom—subway riders are bored all over.

RAPIDO! Mexico City is a mile-and-a-half high. This makes their new subway system the highest underground transit system in the world. Always great builders in stone, Mexican architects have constructed their subway with glass-domed entrances, and cars moving silently on rubber wheels filled
Subway dispatcher, south of the border and two miles high. He operates this model board which lights up all the workings of the subway system and enables him to watch and control action on the rail lines. With the cooperation of French engineers, the Mexicans were able to surmount many problems, among them being earthquakes and shifting subsoil. Ole!

Brain of Metro-Mexico system is this electronic computer, which is housed in midtown Mexico City in a 6-story building. Mexicans point with pride to this—one of the most modern dispatching systems in the world—and they're justified!

Aerial view from outside the Insurgentes station. The modern ramp uncoils like the fabled plumed serpent of Mexico. Down you go and for the equivalent of 9¢ have a quiet, comfortable ride. New York Transit Authority, please copy!

Over 5000 pieces of ancient Aztec art were unearthed during construction. Here we show an Aztec temple which the architects incorporated into the design.

with nitrogen to prevent overheating, traveling eight miles on shining rails through brightly lit tunnels.

Crucial to the transportation needs of Mexico City's nearly seven million people, Metro Mexico will be extended another 20 miles for the estimated 11 million gente by 1980.

APRIL/MAY 1970
FAMOUS PATENTS
No. 235,199
ALEXANDER G. BELL'S
PHOTOPHONE

For Alexander Graham Bell, the invention of the telephone was the highlight of a lifetime devoted to helping people communicate. But it was by no means the end of his brilliant research. In 1880, six years after his invention of the telephone, he created the "Photophone"—a wireless telephone that transmitted speech on a beam of light.

Radio was still in the future when plans for the first wireless telephone system began to form in Bell's mind. The idea was triggered by the discovery of the unusual properties of selenium—the rare chemical element that was to form the heart of the photophone. In 1875, scientists working on the Atlantic cable had investigated the possibility of using selenium as an electrical resistor.

Their investigation uncovered a curious fact: the resistance of the element changed according to the amount of light falling on it. News of the strange phenomenon suggested a new line of research to the famous inventor.

In a telephone receiver, variations in resistance and current are reproduced as sound. Why, Bell reasoned, couldn't selenium be incorporated in the circuit in such a way that variations in light falling on it would be transformed into sound? Bell and his associate, Summer Tainter, set up a small laboratory in Washington, D.C. and began to experiment.

The problem was two-fold: First to modu-
(Continued on page 78)
Scientists have discovered birds burn up energy faster than most others in the animal kingdom.

The next time you see a bird wing overhead to flit on out of sight again, accept it as an act of nature. For if you don't, you may be caught up in the mysteries science is trying to answer today. Wilbur and Orville began the modern period of scientific bird study which culminated in the birth of the Boeing 747 superjet. However, as we learn more about birds, we soon discover how much more there is to unravel.

A Flock of 'Em. A team of biologists and engineers at the National Research Council of Canada has completed a five-year study of bird flight physiology. Their work has helped to unravel some of the mysteries of bird flight which have baffled scientists for decades.

The studies, undertaken by biologists in NRC's Division of Biology and engineers in the Radio and Electrical Engineering Division, exemplify the degree of collaboration which exists among NRC scientists. Dr. J. S. Hart, Head of the Animal Physiology Section of the Division of Biology was in charge of the physiological studies. O. Z. Roy of the Medical Electronics Section of REED developed the sophisticated telemetry equipment used in the experiments.

The work produced new information on breathing, body temperature regulation and metabolism in flight. Transmitters weighing less than an ounce carried on the back of homing pigeons, ducks, gulls, and other birds, monitored information on breathing, wing beat, heart rates, and other events during flight, which was recorded by transducers placed in a rubber mask over the beak or on various parts of the body. A long nylon fishing line attached to a harness on the bird was used to prevent its escape and pull it down to earth after each test.

Dr. Hart says that answers were sought on three main questions. Is breathing during flight co-ordinated with wing action? How much does body temperature, metabolism and heart activity increase during flight?
BIRD WATCHERS

How is the heat production lost—through evaporation of water from lungs and air sacs or mostly by air convection through the feathers?

They're Hot. Measurement of body temperature, done for the first time in free flight of pigeons, showed that the normally high temperatures of these birds were elevated even more during flight to a record level of 113°F, compared with a maximum of about 104°F in man during heavy exercise. The temperature of a pigeon at rest is 107°F.

Real Flappers. In the pigeon and in the crow, it was found that breathing and wing beats were perfectly co-ordinated, with inspiration (inhalation) occurring always on the upstroke of the wing, but in most species wing action was much faster than breathing. Basically the two functions are independent, which provides a basis for interrupted song during flight, but there was usually a co-ordination ranging from three to five wing strokes per breath.

Measurements of lung ventilation and oxygen content of the air exhaled from the mask gave very high estimates of heat production in flight. This ranged from 12 to 15 times basal (the rate at which heat is given off by an organism at complete rest) and was equivalent to near maximal increases in well trained animals during heavy exercise. Dr. Hart says, “the expenditure of energy in flight might very well be among the highest of energy capabilities in the animal kingdom.”

They Have Heart. The heart frequency in flight is remarkably high with rates up to 20 beats per second in small birds compared with three per second in man during heavy work. From the oxygen consumption and heart rate, it is estimated that a small bird would circulate at least twice its weight of blood every minute.

With the high energy expenditure, the heat dissipation during flight becomes a problem, particularly under warm conditions. Contrary to older theories it was found that about 85 percent of this heat is lost by convection. In other words, it is dissipated mainly by air cooling through the feathers rather than water cooling; by evaporation from lungs and the many air sacs in the bird's body. This has the advantage of greatly reducing dehydration in long migratory flights, but raises the mystery of how this is accomplished in a heavily feathered bird.

Note differences in heart beat of pigeon in flight (chart on right) and of pigeon at rest (chart on left).

Respiration of pigeons in flight and at rest. Chart at left taken from pigeon landing and at right from pigeon in flight.
Wullie Tamson wants a room. He says he and his students must perform experiments." Tongues clucked and heads wagged among assembled dignitaries of Glasgow University. A few scholars smiled at the slur implied by use of the vernacular form of Thomson's name.

"Wants a room, does he?" responded a white-haired professor. "Move out the barrels, and give him the old wine cellar!"

That suggestion was accepted. Within weeks 22-year-old Professor William Thomson had installed simple equipment and was giving demonstrations in Great Britain's first physics laboratory. Colleagues laughed at him but he paid no attention. All his life he had been a non-conformist.

Youngest of six children, William never attended secondary school. He learned Latin from his father (himself a professor at Glasgow) and from age 10 attended lectures along with college students. At 17 he entered Cambridge. There he won few friends, but before his graduation in 1845 had gained fame as a mathematical genius.

Honors were old hat to Thomson; he'd won his first prize at 12 for translating a Latin tract. Before he was 15 he had won a prize in natural philosophy (a discipline then roughly equivalent to present-day "science"). At 18 he won a prize in astronomy plus a university medal for an essay on earth's shape.

Modesty was not one of his attributes. Still, his first scientific paper appeared in the Cambridge Mathematical Journal under a pseudonym. He fumed and fussed, finally agreed to use it because his father's friends said an undergraduate shouldn't be publishing original papers. Twelve of his research papers were in print before he won his diploma; but he didn't publish under his own name until he held a university degree.

Long before he won it, his father and he had set their eyes on a coveted prize. Meikleham, venerated professor of natural philosophy at Glasgow, was getting old. A successor would be needed soon.

When Meikleham died in May, 1846, the Thomson's moved quickly. Within weeks Glasgow University electors had 30 testimonials, all from eminent scientists, attesting the brilliance and great promise of young Thomson. He was elected to the faculty at 22—and within a few weeks was asking for space outside his lecture room where he could arrange "demonstrations."

Even before the physics lab was launched, he set out to prove himself in the eyes of fellow teachers. Within a month after beginning his duties he produced a brilliant paper, just 4 pages long, showing that forces
of electricity and magnetism can be represented by distortions of an elastic solid.

As the years passed, he investigated practically all the physical sciences and made important theoretical contributions to many. He formulated the basic laws of thermodynamics, suggested adoption of the absolute scale of temperature that still bears his name, refined existing theories about electricity and magnetism, calculated the age of the earth as "not more than 100,000,000 years."

Later discoveries challenged his conclusions about our planet's age, but all his life he clung stubbornly to his own estimate.

In public and in private he was completely unpredictable. When he lectured on sound, he was likely to smuggle a rifle into his classroom and fire it without warning. He kept memo pads in his pockets, often ignored guests at dinner parties as he turned his attention to mathematical problems.

Still, this man absorbed with the abstract

Famous Patents

Continued from page 74

late a light beam with the sound vibrations from a human voice; and then to transform the modulated light back to sound.

The two scientists tested dozens of transmitting and receiving circuits before arriving at a workable system. Finally, on a clear day in February 1880, the invention was ready to be tested. Tainter carried the transmitter to the roof of a nearby school building, focused a beam of sunlight through the transmitter toward the laboratory window, an eighth of a mile distant, and spoke into the mouthpiece. In the laboratory, as the light was beamed through the window, Bell heard the sound of Tainter's voice in the receiver.

Bell filed a patent application and, before the end of the year, U.S. Patent 235,199 was granted on the photophone. Later patents on inventions relating to the photophone were granted to both Bell and Tainter. Bell had high hopes for commercial development of his wireless system when, under an existing agreement, he assigned the patent rights to the newly-formed Bell Telephone Co.

But the invention was destined for obscurity. As things turned out, the struggling young company was in the middle of a long legal battle over the basic telephone patent and had no resources to spare for the development of Bell's latest invention. So the photophone was pigeon-holed. During the next two decades, a more practical form of wireless (radio) arrived on the scene and the light beam approach of the photophone was all but forgotten. It became another fascinating but little-known invention.

In the version of the photophone shown here (taken from Bell's original patent) light is concentrated through a lens to the polished metal diaphragm of a telephone transmitter. The light is reflected by the diaphragm through a focusing lens and beamed to the receiver. There it is concentrated by a parabolic mirror to a selenium cell which is part of the telephone receiver circuit. When the operator speaks into the transmitter mouthpiece, the diaphragm vibrates, scattering the light and varying the amount of light that falls on the selenium cell. This, in turn, varies the resistance of the cell and the current in the receiver circuit. The fluctuating current is reproduced as sound by an electromagnetically controlled diaphragm.

It may be that the photophone—dormant for nearly a century—has been re-discovered. With the advent of the laser, physicists are once again investigating the use of light for communication. The powerful, coherent light of the laser may provide the key to a modern version of Alexander Graham Bell's photophone.

Horace Twipple
Continued from page 60

a secondary radiation after the rays first strike the earth. We believe that this concentration is highly radioactive in carbon.”

That night Horace sat in his apartment thinking.

“Carbon 14... Geiger counters... cosmic ray neutrons at 40,000 feet... a mummy’s hair 5800 years old. How does this stuff add up to bringing radio back?” He gave up and turned on the TV set to watch an old film of Cleopatra starring Theda Bara. When it was over he went to bed—not to sleep, but to think.

“I wonder what Cleopatra really whispered in Marc Antony’s ear on that barge? Too bad I can’t just tune my shortwave set in on sound waves from other times. Someone ought to invent some...”

He sat up suddenly. The Madame’s words came back, “You are going to invent something spectacular.” That was it. Sound waves reproduced from the past. That was what Pluto was sniffing in the sky.

“Let’s see now. Sound waves spread out in all directions. Some of them would go up and reach this 40,000-foot layer of concentrated radioactive, carbon-coated neutrons. Why wasn’t it possible for them to fuse with the neutrons? The cosmic rays would keep them alive by means of radioactivity.” But how could he separate them to find one year from another? He would fuse his shortwave signals from his transmitter with carbon isotopes of mass 14 and use the archaeologist’s carbon 14 method to send up the correct strength into the neutron layer. When his shortwave signals bounced back they would bring the radioactive sound waves with them.

There must be millions of ready-made radio programs floating around in the Twipple Belt (as he named it), waiting for him to bring them down and record them on tape. If he sold each one for five thousand dollars he’d have more money than any Swiss bank.

He was up early the next morning working on diagrams. Where was he to get the radio telescope, computers, and other equipment he needed to make a test? His old pals down at the Guaymas tracking station would let him use the equipment. He packed his bags.

When he arrived at Guaymas, he found that Professor Wolfgang Brawn from the Houston Space Center was visiting the station. Horace decided to confide in the professor as he needed someone to serve as a reputable witness or the world would never believe his tapes were authentic.

By concentrated work, everything was wired up for a test that same night. Horace decided to record Cleopatra’s voice for the test. He gave the computer the location of the ancient city of Alexandria, Egypt. Then he set the carbon-14 Geiger counter device back to 2014 years ago as the beautiful queen had lived from 68 to 30 BC. The last adjustment was to the computer to translate the Egyptian language into English before recording on the final tape.

Horace held his breath as he watched the telescope slowly swing in an arc under the guidance of the computer until it stopped. The shortwave set was wired in relay and he pressed the switch for a few seconds. Almost immediately the signal returned and the computers went into action as everyone shouted in excitement and waited. The radioactive, carbon-coated sound signals were amplified, put into transducers, and converted to electric signals. The output was then recorded.

Horace’s hand shook as he prepared to play the reel back and turned on the recorder. “Listen, Marc, my love,” came the dulcet tones of the seductive Cleopatra. “If you think you’re going to slip into my pad just for kicks, you’re off your Roman rocker. Just get up and put your toga back on and get the—out of here. Besides, you’ve got cold feet. Come back when you can give me Rome. Don’t slam the drapes when you leave.”

The voice and the tape came to an end as Professor Brawn cried, “You’ve done it. You are a genius, Mr. Twiddle, a genius!”

“The name is Twipple,” said Horace gently as he smiled.

The following hours were spent in excited activity as the little group recorded tapes from various places and times in the past. The professor had phoned his Space Center as well as the New York Times to give them full information of the amazing discovery. When Horace stepped off his plane in New York the next day he found himself facing a barrage of news reporters and microphones.

“When will we hear some of your amazing tapes, Mr. Twipple?”

“Watch the radio programs in the daily
papers,” he replied with gusto!

He took a cab to the buildings of the American Radio Corporation on Fifth Avenue and a few minutes later was seated in the private office of P. R. Gomple, president of the vast organization.

“Your discovery is absolutely incredible, Mr. Twipple,” said Gomple. “Did you bring along any of the tapes you recorded?”

“Yes. I have one of Noah talking to some friends after his trip in the Ark. I have a violin solo by Nero. Also, I have Lincoln giving the Gettysburg Address. Of course I can record anything you ask for,” said Horace calmly. “I will sell you exclusive rights for this country for two broadcasts for . . . twenty thousand dollars per tape.”

“Agreed. I’ll have a contract drawn up immediately,” said Gomple. “Man alive, just watch the Hoople rating go down on the programs of that lousy C.S.B. television outfit when I put on some of these tapes.” He pressed a desk button to call his secretary.

The next weeks were busy ones for Horace. He signed contracts at fabulous prices to record the philosophic speeches of Plato to be issued in book form. He signed radio rights for the use of tapes in foreign countries. He signed contracts with Hollywood. His bank account was so large they couldn’t get the figure on one page.

Finally, when he learned that the stock of C.S.B. was at an all-time low, he bought controlling interest of the company and moved into the office of the late president. After having his secretary type a few words on a slip of paper he walked down to Studio B.

A panel show produced by Mr. Pidmore was on the air and before the TV cameras. Horace walked into the middle of the set.

“Good morning, you TV viewers,” he said as he faced the live camera. “May I interrupt the show briefly. I am Horace Twipple, the new president of C.S.B. and I see Mr. Pidmore, the producer of this show sitting over there. Will you come up here, Mr. Pidmore?”

There was a ripple of polite applause from the small studio audience as the white-faced producer walked slowly up to Horace.

“Will you kindly read this announcement, Mr. Pidmore?” said Horace as he handed the man the small slip of paper.

“ . . . I . . . a stupid idiot,” said Mr. Pidmore in a weak voice as the audience began to laugh. “Mr. Twipple is a brilliant genius.”

“Thank you, Mr. Pidmore, and on with the quiz show,” said Horace as he walked out of the studio and went to find the chorus girl he had admired a few months previous. She probably would like to have a sports car or a mink coat or two. No, Horace did not fire Mr. Pidmore—Horace knows what damage an unemployed man can do.

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**Treasure Witcher**

*Continued from page 44*

... and enjoy treasure hunting isn’t your little practice may be in order. Place coffee cans, pie pans, or any good-sized metal object on the ground and use the WITCHER to locate the metal objects to get a good idea of its operation. (Actually, the unit is more sensitive when the balance adjustment is set where the meter will read up scale a division or two—this adjustment should be made away from any metal.)

If treasure hunting isn’t your brew, then perhaps locating buried water, gas, or other hidden pipes will be more up your alley. Use your WITCHER and enjoy it!
An up-to-date Directory of North American AM, FM, and TV Stations, including special sections on World-Wide Shortwave Stations and Emergency Stations for Selected Areas

### WHITE’S RADIO LOG CONTENTS FOR 1969-1970

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### U.S. Television Stations by States

**Ch.** channel; **C.L.** call letters; **1.** educational station; **2.** non-commercial station.

#### Listing indicates stations on the air as of January 1, 1970.

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### Canadian AM Stations by Frequency

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<th>Wave Length W.P.</th>
<th>Location</th>
<th>Station</th>
<th>Call Letters</th>
<th>Programming</th>
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<tr>
<td>540</td>
<td>555.5</td>
<td>CBK Regina, Sask.</td>
<td>5,000</td>
<td>CKCI</td>
<td>AM, FM, TV</td>
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<tr>
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<td>555.5</td>
<td>CBT Grand Falls, Nfld.</td>
<td>10,000</td>
<td>CJIB</td>
<td>AM, FM, TV</td>
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<tr>
<td>550</td>
<td>545.1</td>
<td>CBFR Sudbury, Ont.</td>
<td>150,000</td>
<td>CKIC</td>
<td>AM, FM, TV</td>
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<td>CBFR Sudbury, Ont.</td>
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<td>CBLT</td>
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<tr>
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<td>545.1</td>
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<td>30,000</td>
<td>CKPK</td>
<td>AM, FM, TV</td>
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<tr>
<td>550</td>
<td>545.1</td>
<td>CKPG Prince George, B.C.</td>
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<td>CBO</td>
<td>AM, FM, TV</td>
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**January 1970**

<table>
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<th>Station</th>
<th>Call Letters</th>
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<td>CKPG Prince George, B.C.</td>
<td>10,000</td>
<td>CBO</td>
<td>AM, FM, TV</td>
</tr>
</tbody>
</table>

### Abbreviations:
- kHz: kilohertz
- Wave Length: in meters
- AM: AM broadcast
- FM: FM broadcast
- TV: TV broadcast

### Notable Stations:
- CKSB - Saskatoon, Saskatchewan
- CHNL - Toronto, Ontario
- CHAB - Vancouver, British Columbia
- CFRC - Montreal, Quebec
- CFCN - Edmonton, Alberta
- CHUM - Montreal, Quebec
- CKRL - Calgary, Alberta
- CJOH - Windsor, Ontario
- CBLT - London, Ontario
- CFMB - New York, New York
- CFRB - Miami, Florida
- CKNW - Los Angeles, California
- KSL - Salt Lake City, Utah

### Kilowatts:
- W.P.: Watts Peak
- Watts: Watts Average

### Wave Lengths:
- Waves: 500 - 3,000 meters
- Kilometers: W.P. in watts; meters
5 New Better-Value Kits From Heath

**New Heathkit 100-Watt AM/FM/FM-Stereo Receiver**

World's finest medium power stereo receiver ... designed in the tradition of the famous Heathkit AR-15. All Solid-State ... 4 integrated circuits containing another 56 transistors and 24 diodes. 100 watts music power output at 8 ohms — 7 to 60,000 Hz response. Less than 0.25% distortion at full output. Direct coupled outputs protected by dissipation-limiting circuitry. Massive power supply. Four individually heat sunked output transistors. Linear motion bass, treble, balance and volume controls. Push-button selected inputs. Outputs for 2 separate stereo speaker systems. Center speaker capability. Stereo headphone jack. Assembled, aligned. FET FM tuner has 1.8 uV sensitivity. Two tuning meters. Computer designed 9-pole L-C filter plus 3 IC's in IF gives ideally shaped bandpass with greater than 70 db selectivity and eliminates alignment. IC multiplex section. Three FET's in AM tuner. AM rod antenna swivels for best pickup. Kit Exclusive: Modular Plug-In Circuit Boards ... easy to build & service. Kit Exclusive: Built-In Test Circuitry lets you assemble, test and service your AR-29 without external test equipment. The AR-29 will please even the most discriminating stereo listener.

- **Kit AR-29**, (less cabinet), 33 lbs. $285.00*
- **AE-19**, Assembled oiled pecan cabinet, 10 lbs. $19.95*

**New Heathkit 60-Watt AM/FM/FM Stereo Receiver**

The AR-19 circuitry reflects many of the advanced concepts of the AR-29. It uses 103 transistors and 45 diodes including those in 5 integrated circuits. It delivers 60 watts music power at 8 ohms. At any power level, Harmonic and IM Distortion is less than 0.25%. Frequency response ranges from 6 to 35,000 Hz. Direct coupled outputs are protected by dissipation-limiting circuitry. A massive power supply includes a section of electronically regulated power. The assembled, aligned FET FM tuner has 2.0 uV sensitivity.

A preassembled and factory aligned FM IF circuit board gives 35 db selectivity. The multiplex IC circuit provides inherent SCA rejection. It features two switched noise muting circuits; linear motion controls for bass, treble, volume and balance; input level controls; outputs for 2 separate stereo speaker systems; center speaker capability; two tuning meters; stereo indicator light; front panel stereo headphone jack. The Modular Plug-In Circuit Board design speeds assembly. Built-In Test Circuitry aids assembly, simplifies servicing. "Black Magic" panel lighting, black lower panel, chrome accents. Compare it with any model in its price range ... the AR-19 will prove itself the better buy.

- **Kit AR-19**, (less cabinet), 29 lbs. $225.00*
- **AE-19**, cabinet, 10 lbs. $19.95*

**New Heathkit Deluxe 18-Watt Solid-State Stereo Phono**

Looks and sounds like it should cost much more. Here's why: 16-transistor, 8-diode circuit delivers 9 watts music power per channel to each 4-1/2" high-compliance speaker. Speaker cabinets swing out or lift off ... can be placed up to 10" apart for better stereo. Has Maestro's best automatic, 4-speed changer — 16-33-1/3, 45 & 78 rpm. It plays 6 records, shuts off automatically. Ceramic stereo cartridge with diamond/oakite stylus. Has volume, balance & tone controls. Changer, cabinet & speaker enclosures come factory built ... you build just one circuit board ... one evening project. Wood cabinet has yellow-gold & brown durable plastic coated covering. This is a portable stereo you can take pride in.

- **Kit GD-109**, 38 lbs. $74.95*

**New Heathkit Solid-State Portable Fish-Spotter**

Costs half as much as comparable performers. Probes to 200 ft. Spots individual fish and schools ... can also be used as depth sounder. Manual explains typical dial readings. Transducer mounts anywhere on suction cup bracket. Adjustble Sensitivity Control. Exclusive Heath Noise-Reject Control stops motor ignition noise. Runs for 80 hrs. on two 6 VDC lantern batteries (not included). Stop guessing — fish electronically.

- **Kit MI-29**, 9 lbs. $84.95*

**New Heathkit Solid-State Depth Sounders**

Let its flashing indicator light guide you through strange waters ... day or night. Sounds to 200 ft. Has Noise Rejection and Sensitivity controls. Operates from your 12 VDC boat battery. Sun-shielded dial. All solid-state.

- **Kit MI-19-1**, (with thru-hull transducer), 7 lbs. $69.95*
- **Kit MI-19-2**, (with high speed transom mount), 7 lbs. $69.95*

**Science & Electronics**
NEW IMPROVED 1970 HEATHKIT® COLOR TV
New Lower-Than-Ever Prices

Here’s How The Color TV That Thousands Call Best Became Even Better and Lower In Price

Since the very first model was introduced, thousands of owners, electronic experts, and testing labs have praised the superior color picture quality and extra features of Heathkit Color TV. Now Heath has made improvements that make the 1970 models even better.

Sharper, More Detailed Pictures. Latest design improvement in the circuitry of Heathkit Color TV video amplifiers has increased their bandpass capabilities. The result is an increase in the number of lines of resolution... greater than in any other brand of color TV we have tested. This improvement means you get sharper, more detailed pictures as shown by test pattern measurements. You not only get the superior color pictures Heathkit Color TV has always been noted for, but you also get sharper pictures.

New Brighter Tube. Now all Heathkit Color TV models include the new brighter picture tube you’ve read so much about. These new tubes produce noticeably brighter pictures with more life-like, natural colors and better contrast. (We also offer the RCA Hi-Life Matrix tube as an extra-cost option for the Heath GR-581 and GR-295 kits.)

New Safety Features. As an added safety precaution, AC interlocks have been added to all Heathkit Color TV cabinets.

New The Best Costs Less. How can Heath make improvements in its Color TV Models and still reduce the prices? We have passed on to you the savings which have accrued due to reduced picture tube prices. The result is your 1970 Heathkit Color TV will cost you $20 to $55 less depending upon which model you choose... proof that Heathkit Color TV is a better buy than ever.

All Heathkit Color TV’s Have These Superior Features

• New brighter American brand rectangular color tube with bonded-face, etched antiglare safety glass • Exclusive built-in self-servicing aids so you can adjust and maintain the set for best performance always • Automatic degaussing plus mobile degaussing coil • New broader video bandwidth for better resolution • 2-stage video IF • Improved retrace blanking • Gated automatic gain control for steady pictures • Automatic color control • Exclusive Magna-Shield surrounds picture tube for better color purity • Deluxe VHF tuner with “memory” fine tuning and precious metal contacts (models with automatic fine tuning also are available in all 3 picture tube sizes) • 2-speed UHF solid-state tuner • Completely shielded hi-voltage supply • Extra B+ boost for better definition • 2 hi-fi sound outputs for built-in speaker or your hi-fi system • 300 ohm & 75 ohm antenna inputs • Circuit breaker protection • Optional wireless remote control can be added anytime • Factory assembled and adjusted tuners. IF section, and hi-voltage supply • Exclusive 3-way installation capability — in a wall, custom cabinet or Heath cabinets

Choose Your Heathkit Color TV Now...
It's Better Than Ever in Performance... and A Better Buy Than Ever

NEW
FREE 1970 CATALOG!
Now with more kits, more color, fully describes those along with over 300 kits for stereo/hifi color TV, electronic organs, guitar amplifiers, amateur radio, marine, aviation, CB, home & hobby. Mail coupon or write Heath Company, Benton Harbor, Michigan 49022.

HEATH COMPANY, Dept. 15-4 Benton Harbor, Michigan 49022
□ Enclosed is $... plus shipping.
□ Please send model (s)...
□ Please send FREE Heathkit Catalog.
□ Please send Credit Application.

Name...
Address...
City...
State...
Zip...

*Mail order prices; F.O.B. factory. Prices & specifications subject to change without notice.

NEW LOWER-THAN-EVER PRICES ON ALL MODELS

Heathkit GR-581
(295”-AFT)
save $30
Now only $469.95

Heathkit GR-581MX
(with Matrix tube)
save $95
Now only $479.95

Heathkit GR-295
(295”)
save $30
Now only $419.95

Heathkit GR-295MX
(with Matrix tube)
save $95
Now only $429.95

cabinets from $65

Heathkit GR-581
(227”-AFT)
save $20
Now only $399.95

cabinets from $29.95

Heathkit GR-227
(227”)
save $20
Now only $359.95

cabinets from $23.95

Heathkit GR-481
(180”-AFT)
save $30
Now only $329.95

cabinets from $20

Heathkit GR-180
(180”)
save $30
Now only $299.95

cabinets from $27.50

APRIL/MAY 1970
89
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<th>Station</th>
<th>City</th>
<th>Province</th>
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<td>CFNL</td>
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<td>1200</td>
<td>5000</td>
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<td>Sudbury, Ont.</td>
<td>1500</td>
<td>10000</td>
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<td>Edmonton, Alta.</td>
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<td>5000</td>
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<td>10000</td>
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<td>CJBC</td>
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<td>10000</td>
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<td>CKKN</td>
<td>St. John's, NfD</td>
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**Wave Length**

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<th>City</th>
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<td>St. John's, NfD</td>
<td>1250</td>
<td>10000</td>
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**Wave Length**
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<tr>
<th>kHz</th>
<th>Wave Length</th>
<th>W.P.</th>
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<tr>
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<td>250n</td>
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<td>CKSL London, Ont.</td>
<td>10,000d</td>
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<td>CKPT Peterborough, Ont.</td>
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<td>CGB Quidi Vidi, Nfld.</td>
<td>10,000d</td>
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<td>CFBV Vancouver, B.C.</td>
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<tr>
<td>CHER St. Elmoere, Que.</td>
<td>10,000d</td>
<td>250n</td>
</tr>
</tbody>
</table>

**White's World-Wide Shortwave Stations**

*Prepared by Don Jensen*

A number of readers report hearing a station announcing as Tropical Radio and Telegraph Co., Panama City, Republic of Panama. Its announcement, repeated endlessly it seems, also gives a “plug” for the 11th annual Olympics of Central America.

Is this a new station, some have asked? How can I get a QSL, queried others?

Actually, Tropical Radio and Telegraph Co. is no newcomer to shortwave. But it isn’t even a broadcasting station. It is a fixed service, or point-to-point operation whose purpose is to transmit messages between two points in this hemisphere, rather than to air programs for general reception. DXers commonly refer to operations like this as utility stations.

What listeners are hearing is a voice mirror, or a repeated, tape recorded identification for tuning purposes used by the receiving station to make the proper circuit adjustments before actual traffic is sent. While cavedropping on the messages is legally a no-no, nothing prohibits you from tuning and reporting these repeated test identifications.

Tropical Radio and Telegraph transmitters use a number of different frequencies and several transmission modes, including normal amplitude modulation (AM), single sideband (SSB) and code (CW). Most DXers find the AM transmissions during the evening hours most easily heard.

T.R.T.’s Panama City transmitters include HOD78, 7,872.5 kHz., HPI, 9,132.5 kHz., HPH, 10,670 kHz., and HOD24, 20,727.5 kHz., to name a few.

Reports, including the exact voice mirror text you hear, may be sent to the Chief Engineer, Tropical Radio and Telegraph Co., Panama, Panama. Return postage, in the form of International Reply Coupons, available for 15¢ at your post office, or unused Panamanian stamps, should be enclosed.

Other T.R.T. stations operating in the fixed service from Central America are TGB, 11,580 kHz., Barcenas, Guatemala; YND3, 3,190 kHz., YN2A, 4,807.5 kHz., and YNA2, 7,600 kHz., all in Managua, Nicaragua; HRB4/HR14, 6,905 kHz., Tegucigalpa, Honduras; and HQL2, 5,780 kHz., La Lima, Honduras.

**Happy News.** On November 19, 1928, a young Dutchman named Edward Startz began his broadcasting career with the experimental Philips Light and Radio Company’s shortwave station, PCJ, now part of Radio Nederland. Though hired for “straight” announcing, he found the routine a drag and soon began injecting some of his own personality to “hypo” up the dull programming. Soon listeners learned to know PCJ by Startz’s new slogan, “The Happy Station of a Happy Nation!”

His brand of broadcasting caught on and for more than 40 years he spread the message of Peace, Cheer and Joy (the initials, of course, spelling PCJ) throughout the world with his Happy Station programs each Sunday. But now, after two score years, he has handed the program over to other hands—rumor has it not altogether willingly—and retired.

His departure came as sad news to followers of the Radio Nederland show. Over the years his trademark was his sense of humor and a light touch characterized the Happy Station...
Science and Electronics Propagation Forecast for April/May 1970

Prepared by C. M. Stanbury II

<table>
<thead>
<tr>
<th>LISTENER'S STANDARD TIME</th>
<th>ASIA (except Near East)</th>
<th>EUROPE, NEAR EAST &amp; AFRICA (N. of the Sahara)</th>
<th>AFRICA (S. of the Sahara)</th>
<th>SOUTH PACIFIC</th>
<th>LATIN AMERICA</th>
</tr>
</thead>
<tbody>
<tr>
<td>0000-0300</td>
<td>31</td>
<td>(41)</td>
<td>(41), 49e, (60e)</td>
<td>41, (75), (90)</td>
<td>49, 60</td>
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<tr>
<td>0300-0600</td>
<td>41, 49</td>
<td>(31)</td>
<td>49w</td>
<td>49, 60, 90</td>
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<td>0600-0900</td>
<td>25</td>
<td>16, 19</td>
<td>19</td>
<td>25, 31</td>
<td>31</td>
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<tr>
<td>0900-1200</td>
<td>19, 25</td>
<td>16, 19</td>
<td>19, 25</td>
<td>(19)</td>
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<tr>
<td>1200-1500</td>
<td>19</td>
<td>16, 19</td>
<td>19, 25</td>
<td>(19)</td>
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<tr>
<td>1500-1800</td>
<td>19, (41), (49e)</td>
<td>25, 31</td>
<td>41w, 60, 90e</td>
<td>19, 25</td>
<td>25, 31</td>
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<tr>
<td>1800-2100</td>
<td>16, 19</td>
<td>25, 31</td>
<td>25, 31e, 60, 90w</td>
<td>16, 19</td>
<td>49, 60</td>
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<td>2100-2400</td>
<td>16, 19, (31w)</td>
<td>31, 41, 49</td>
<td>60, 90</td>
<td>18, 31w</td>
<td>49, 60</td>
</tr>
</tbody>
</table>

To use the table, put your finger on the region you want to hear and log, move your finger down until it is alongside the local standard time at which you will be listening and lift your finger. Underneath your pointing digit will be the shortwave band or bands that will give the best DX results. The time in the above propagation table is given in standard time at the listener's location, which effectively compensates for differences in propagation characteristics between the East and West Coasts of North America. Abbreviations: w—Western North America and e—Eastern North America. When w or e follow a band listing, it means the band is only good for that part of the continent. The shortwave bands in brackets are suggested as possible second choices. Refer to White's Radio Log for our world-wide Shortwave list.

programs. Many recall his slogans, "Keep in touch with the Dutch," and his familiar "nice cup of tea." His listeners were the "W.L.H." the "World's largest happy family." The show was populated with his imaginary animal gang (the horses, Happy, Pappy, Bright and Breezy, Pasha the dog and Ella the cow.). Then there was the repeatedly asked question, "Is everybody happy?"

Except for the war years, when the Dutch station was operated as a Nazi propaganda outlet, Startz's motto was "The show must go on." And so it will.

His successor is another Radio Nederland announcer, 32-year-old Tom Meyer. Meyer was born in Amsterdam in 1938 and his parents smuggled him out of occupied Holland when he was three. Via France, Spain and Cuba he reached the Netherlands West Indies, where he spent his childhood. Then after three years in Singapore, he returned to the Netherlands in 1949. First a law student, then a musical entertainer, he joined Radio Nederland's staff in 1965.

Like Eddie Startz, Meyer is a linguist and will continue the Happy Station program in both English and Spanish versions. Frankly, it won't seem the same without Eddie's familiar voice, but we suspect his basic aim over the years—creating a happy mood for all Happy Station listeners—will continue.

If you're one of the few who've never tuned the program, try next Sunday at 1830 GMT on 15,220 kHz., or, relayed from Bonaire at 0200 GMT Monday on 11,730 kHz.

This Issue's Shortwave Contributors

Gerry Dexter (Wis.); Marlin Field (Mich.); Bill Sparks (Cal.); Edward Shaw (Cal.); Gregg Calkin (Canada); F. Earle Hall (Mass.); Alwin Sizer (Conn.); Richard Wood (Hawaii); George Schnabel (N.Y.); Dan Ferguson (Fla.); Del Hirst (Tex.); Stanley Cabral (Cal.); Bill Berghammer (N.Y.); David Potter (Fla.); Tom Williamson (Canada); A. R. Niblack (Ind.); C. Vernon Hyson (N.J.); Mark Koukol (Ill.); Grady Ferguson (N.C.); Dick Heggs (Canada); Syd Wells (Wash.); Joseph Breton (Mass.); Harold Honnold (Cal.); Bob Nagerman (Mich.); Gladys Sienkiewicz (N.Y.).

Newark News Radio Club, 215 Market St., Newark, N.J.
North American SW Association, Box 989, Altoona, Penna.
Sun Up! Medium wave DXers know that sunrise and sunset are great times for DXing U.S. and Canadian stations in the AM broadcast band. Propagational conditions are in a state of flux during these times and some really good distant listening is possible. Also, because FFC regulations limit many stations to daylight operating hours, it is useful to know when old Sol rises and sets at various locations across the continent.

So, broadcast band listeners will be interested in a 13-page booklet called “Average Monthly Local Sunrise and Sunset Times.” This map-packed pamphlet prepared by the International Radio Club of America should help in tuning some of the more distant, low powered domestic medium wave stations. And, the best thing about it is that it’s a freebee!

- Don Ecriston, 6059 Essex Street, Riverside, California, 92504, is the man to write for your free copy. Though Don didn’t say so, we imagine he’d appreciate a stamped, self-addressed, large-sized envelope with 18-cent postage affixed. There are about 600 copies left, so beat the rush and send for yours today.

And, while we’re on the subject of aids for the medium wave listener, we’d recommend the National Radio Club log. It is a dandy, with schedules and mailing addresses for all medium wave stations in the U.S. and Canada, listed by frequency. When used together with our own White’s Radio Log, it’s a great help to BCB listeners.

You can get yours for $1.22, postpaid, from National Radio Club, P.O. Box 99, Cambridge, Mass., 02138.

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<th>Call</th>
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90-Meter Band—3200 to 3400 kHz

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<td>Aracaju, Brazil</td>
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60-Meter Band—4750 to 5060 kHz

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49-Meter Band—5950 to 6200 kHz

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April/May 1970
### 41-Meter Band—7100 to 7300 kHz

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<td>R. Biafra</td>
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<td>Far East Network</td>
<td>Tokyo, Japan</td>
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<td>CKZN</td>
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### 31-Meter Band—9500 to 9775 kHz

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### 25-Meter Band—11700 to 11975 kHz

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<td>1175</td>
<td>WINB</td>
<td>World International Bc</td>
<td>Red Lion, USA</td>
<td>2100</td>
</tr>
<tr>
<td>1175</td>
<td>PR139</td>
<td>R. Nacional</td>
<td>Rio de Janeiro, Brazil</td>
<td>0145</td>
</tr>
<tr>
<td>1179</td>
<td>R. Ceylon</td>
<td>Colombo, Ceylon</td>
<td>1130</td>
<td></td>
</tr>
<tr>
<td>1180</td>
<td>R. Nacional de Espana</td>
<td>Tenerife, Canary Islands</td>
<td>0200</td>
<td></td>
</tr>
<tr>
<td>1180</td>
<td>R. Asiatique</td>
<td>Rome, Italy</td>
<td>0110</td>
<td></td>
</tr>
<tr>
<td>1180</td>
<td>R. Eire Europe</td>
<td>Lisbon, Portugal</td>
<td>0745</td>
<td></td>
</tr>
<tr>
<td>1185</td>
<td>R. Tahiti</td>
<td>Papeete, Tahiti</td>
<td>0430</td>
<td></td>
</tr>
<tr>
<td>1185</td>
<td>R. El Espectador</td>
<td>Montevideo, Uruguay</td>
<td>0330</td>
<td></td>
</tr>
<tr>
<td>1185</td>
<td>R. Omdurman</td>
<td>Omdurman, Sudan</td>
<td>0730</td>
<td></td>
</tr>
<tr>
<td>1185</td>
<td>4VEH</td>
<td>Evangelistic V. of West Indies</td>
<td>Cap Hoite, Haiti</td>
<td>1130</td>
</tr>
</tbody>
</table>
### 19-Meter Band—15100 to 15450 kHz

<table>
<thead>
<tr>
<th>kHz</th>
<th>Call</th>
<th>Name</th>
<th>Location</th>
<th>GMT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1504</td>
<td>V. of Vietnam</td>
<td>Hanoi, N. Vietnam</td>
<td>1900</td>
<td></td>
</tr>
<tr>
<td>1508</td>
<td>R. Hisi</td>
<td>Bombay, India</td>
<td>1800</td>
<td></td>
</tr>
<tr>
<td>1509</td>
<td>R. Euzkadi</td>
<td>Unknown</td>
<td>2250</td>
<td></td>
</tr>
<tr>
<td>1510</td>
<td>R. Peking</td>
<td>Peking, China</td>
<td>0000</td>
<td></td>
</tr>
<tr>
<td>1510</td>
<td>R. Sweden</td>
<td>Stockholm, Sweden</td>
<td>1200</td>
<td></td>
</tr>
<tr>
<td>1510</td>
<td>ZY3Z</td>
<td>Rio de Janeiro, Brazil</td>
<td>2330</td>
<td></td>
</tr>
<tr>
<td>1511</td>
<td>XERR</td>
<td>Rio de Janeiro, Brazil</td>
<td>2330</td>
<td></td>
</tr>
<tr>
<td>1512</td>
<td>BED</td>
<td>Mexico City, Mexico</td>
<td>2300</td>
<td></td>
</tr>
<tr>
<td>1513</td>
<td>R. Iran</td>
<td>Tehran, Iran</td>
<td>2000</td>
<td></td>
</tr>
<tr>
<td>1513</td>
<td>R. Italy</td>
<td>Paris, France</td>
<td>0245</td>
<td></td>
</tr>
<tr>
<td>1515</td>
<td>YZB</td>
<td>Sao Paulo, Brazil</td>
<td>0100</td>
<td></td>
</tr>
<tr>
<td>1515</td>
<td>Bc</td>
<td>Porto, Finland</td>
<td>1500</td>
<td></td>
</tr>
<tr>
<td>1525</td>
<td>WNYW</td>
<td>New York, USA</td>
<td>2300</td>
<td></td>
</tr>
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</table>

### 13-Meter Band—21450 to 21750 kHz

<table>
<thead>
<tr>
<th>kHz</th>
<th>Call</th>
<th>Name</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>21490</td>
<td>R. RSA</td>
<td>Johannesburg, South Africa</td>
<td>1900</td>
</tr>
<tr>
<td>21540</td>
<td>Swiss Bc</td>
<td>Berne, Switzerland</td>
<td>2000</td>
</tr>
<tr>
<td>21580</td>
<td>O.R.T.F.</td>
<td>Paris, France</td>
<td>1930</td>
</tr>
<tr>
<td>21600</td>
<td>R. Berlin</td>
<td>Berlin, Germany</td>
<td>1330</td>
</tr>
<tr>
<td>21685</td>
<td>R. Kuwait</td>
<td>Kuwait</td>
<td>1530</td>
</tr>
<tr>
<td>21740</td>
<td>R. Veritas</td>
<td>Manila, Philippines</td>
<td>0815</td>
</tr>
<tr>
<td>21740</td>
<td>R. Australia</td>
<td>Melbourne, Australia</td>
<td>0130</td>
</tr>
</tbody>
</table>

### White's Emergency Radio Station Listings for Southern California

Science and electronics furnishes this exclusive listing of emergency radio stations as an aid to our many readers now engaged in the fascinating and rapidly growing hobby of monitoring emergency radio communications. We have and will be publishing similar lists devoted to different metropolitan areas in forthcoming issues so that you will be able to accumulate a sizable array of this difficult-to-obtain data. Refer to the index on page 81 for our 1969/1970 program of emergency radio station listings.

If you desire to obtain similar lists from other areas in the United States that have not been published in this magazine in 1969, then we suggest you write to Communications Research Bureau, Box 56, Commack, N.Y. 11725. They may have a list of emergency radio services that covers your locality. Include a stamped, self-addressed envelope with your request.

All frequencies are megahertz (MHz) unless otherwise noted.

**Los Angeles City Police Dept.**

<table>
<thead>
<tr>
<th>Base Stations:</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>KD358</td>
<td>Radio Service Units</td>
</tr>
<tr>
<td>KME36</td>
<td>(to Sheriff Emerg net)</td>
</tr>
<tr>
<td>KME37</td>
<td>(to Sheriff Spec Enforcement)</td>
</tr>
</tbody>
</table>

**Base/Mobile Channel Matching:**

- Mobiles operate on some channels as base stations with the following exceptions:
- Base Mobiles:
  - 154.065 to 154.565 MHz
  - 154.570 to 155.070 MHz
  - 155.075 to 155.575 MHz

- Base Only Channels:
  - 155.0 to 155.5 MHz

**Los Angeles City Fire Department**

- Base/Mobile Channels:
  - 33.40 to 33.50 MHz
  - 33.55 to 33.60 MHz
  - 33.70 to 33.80 MHz
  - 33.90 to 33.94 MHz
  - 465.250 to 465.325 MHz

- Mobile Only Channels:
  - 33.50 to 46.30 MHz

- Stations:
  - Glendale: KEP65 KLP907

**April/May 1970**
SOUTHERN CALIFORNIA

Los Angeles KBOQ26 KDG872 KEP166 KJR266 KMA075-7
Rolling Hills KLP025
Saugus KMA274
Venice KMA403

LOS ANGELES CITY CD & DISASTER
47.50 KM297-301 KMO307
47.66 KFGS53 KMF202 KMF404 KMM339-44
KMM276

LOS ANGELES CITY LOCAL GOVERNMENT NETWORKS
39.70 KJP422-9 KJW645
153.30 KQA247 KKM53-3 KET64-5 KFV841 KJW655
KJZ990 KMK306 KMM375 KMM614
158.85 KJZ819-21
45.05... KMG202
45.25 KMf546
45.80 KCO300 KMK875-7 (Schools)
458.05 KB012-2 KCS88-65 KDM43 KDO74-4 KMQ39
KJQ23 KMG202 KNT97 KVE71-2 KYT60
458.25 KFZ77-9
458.80 KND88-1

LOS ANGELES COUNTY SHERIFF
Chain Base Mobile Use Calls
37.36 37.36 KM287
4 39.20 39.64 Dispatch KMA628 KFV978
3 39.24 39.70 Dispatch KMA628 KFV978 KMF288
2 39.28 39.74 Dispatch KMA628 KFV978 KMF288
5 39.32 39.78 Dispatch KMA629 KMF288
7 39.36 39.76 Dispatch KMA628-9 KCR20
11 39.48 39.48 Emergency KMA628-9 KCR20 KFV978
6 39.52 39.52 Spec Eng KMA628-9 KCR20
39.98 39.98 KMP54
45.82 45.82 KCU533
45.98 45.98 KFR576 KFR578 KGM567
45.02 45.02 KCW533 KGW761-7
155.19 - KVC52
453.15 - KFF930-1 KJM451

L.A. SHERIFF BASE CALLSIGNS
KCR20 Mt Ada KGW764 W Covina
KCU33 Los Angeles KGW765 Posadena
KCV52 Lancaster KGW766 Downey
KF930 Saugus KGW767 W Los Angeles
KF939 Costa Mt KMA28 LA & other locs
KF576 Baldwin Pk KMA28 LA & Downey
KF578 Gardena KMF287 Ring His & Plos Vrd
KF787 Los Angeles KMF288 portable
KG565 Downey KMF694 Los Angeles
KG761 Van Nuys KJM451 San Dimas
KG762 Compton KGW763 Torrance

LOS ANGELES COUNTY FIRE DEPARTMENT
Bases & Mobiles: 154.34 154.40 154.43
(Stations marked % also operate 154.265 & 154.295 intersystem communications)

Agoura %KMB352 KDMX25 KMY316 El Monte KDX923
Atasica KME463/5 KMG384/6 Glendora KMG248/6
Bellflower KME467 Glendora KLU240-2
Burbank KDV841 House Peak KBG251
Chatsworth KPD778 Huntingdon KKM451
Compton KMG364/5 KMF288 La Canada KMF287
Culver City KME456 ` KMF288 La Mirada KBO582
Diamond Bar KZL753 ` KME458
Lake Hughes KYES16 Norwalk KME466
Lakewood KME460 ` Paramount KJF343
Lancaster KBJ548 ` KMG346
Lowndale KMBG21 Pico KMX251
Lomita KG359 Pica Rivero KMK499
Long Beach KG459 Rolling Hills KMG541
Los Angeles KBO583-4 Rolling His Ests KVL844
` KDP290 Son Simas %KMG941
` KJDB80 Singal Hill KLM622
` %KMA896 Tejan Peak KJF548

"." KKM365/8 Torrance KME461
"." KMG361/3 Whittier KME464
"." KKM448-9 KMG218
Marina Del Rey KFG504 portable base KMG584

LOS ANGELES COUNTY EMERGENCY STATIONS
KMC218 Malibu & Redondo Beach 47.54
KQP460 Los Angeles (hospital) 155.34

LOS ANGELES COUNTY FORESTRY CONSERVATION NETS
44.84 151.16 159.27 169.475 171.875 406.125 412.625

LOS ANGELES COUNTY LOCAL GOVERNMENT NETWORKS
27.235 KDX415
45.56 KAV104 KCB918 KCK780 KEO389 KML382
153.98 KHB339 KBBK398 KEN492 KF7504
KGG556 KGL473 KJ1449-50 KML385-6 KML670
453.15 KIZ618 KMG240
453.725
45.90 KCU23
453.975
458.15 KUT53-3 KUW89
458.90 KCU22

CALIFORNIA HIGHWAY PATROL NEWORKS

Bases Mobiles
42.12 42.12 Yellow Freq. "Y"
42.34 42.18 Blue Freq. "B"
42.40 42.40
42.44 42.44 Red Freq. "R"
42.56 42.98 White Freq. "W"
45.86 45.86
72.28 -- repeaters
73.22 -- point-to-point
73.42 -- point-to-point
74.14 -- repeater
154.92 154.92 CLEARS (Calif. Law Enf Mutual Aid Radio System)
155.43 -- intercity

Base Stations: Networks

Baldwin Park KBOS71 W
Banning KBOS04 B
Barstow KME264 W & 45.86
--- on 42.34
Buellton KBO614 Y
Chatsworth KCV987 B
Chino KLM464 154.92
Claremont KBO577 W
Corona KGD722 B & 42.40
Culver City KBO670 R
--- KMA401 R
--- KLD35 154.92
Descanso KCM394 G
E Los Angeles KBOS72 Y
Escondido KML320 73.14
FT Tejon KED647 B
Gardenia KBO575 B
Glendora KBO573 Y
Gienger KLM456 154.92
Indio KMD892 B & 45.86
--- KJM201 B
--- KJM262 73.22 73.42
Laguna Beach KMB214 G & 42.40
Lancaster KMH724 B
Los Angeles KJ840 154.72
--- KLC324 154.92
--- KMM443 Y & 45.86
--- KMD902 Y (Dept Justice)
--- KMM700 W
--- KMK198 Y
--- KMC215 & 45.02
Malibu KBO574 R
Montebello KJS750 154.92
Montclair KLU423 154.92
Mt Palomar KMG584 G
Mt Soledad KMD711 G
Needles KML956 W
Newhall KMB105 B
Oceanside KMH722 G
--- KML21 73.42
Orange KBC092 B & 45.92
Palmade KFO791 B
Pomona KLC238 154.92
Redlands KKM458 B
Riverside KBO743 B
--- KMD453 B
Running Springs KED677 B
Sacramento Mtn KG371 W
San Bernardino KCMX980 B
Costa Mesa, Cypress, Ftn Valley, Gran Grove, Huntington Bch, Laguna Bch, La Mesa, Los Alamitos, Newport Bch, Orange, Placentia, Seal Bch, Stanton, Tustin, Westminster

45.22 45.22 KMA752 KMG796 (Costa Mesa, Laguna Bch, Orange, San Clemente, St AAna, Santiago)

45.26 45.26 KMA752 (Brea, La Habra, Placentia)

45.30 45.30 KMA752 (Sheriff HQ, University Campus PD)

45.34 45.34 KMA752 (Ftn Valley, Huntington Bch, Los Alamitos, Seal Bch, Westminster)

45.38 45.38 KMA752 KMG796 (Cypress, Grdn Grv, La Mesa, Stanton)

45.66 45.66 KMA752 (Orange, Sta Ana, Tustin)

154.80 158.00 KMA752 Laguna Bch, Orange)

155.43 — KMM853 (Intercty)

158.79 — KMG294 (Santiago Pk)

453.10 458.10 KMA752 (Lomas, Orange)

453.75 — KMD650 (Point-to-point)

460.025 465.025 KMA752 (Olldo)

460.05 465.05 KMA752 (Olldo)

460.10 465.10 KMA752 (Lomas)

460.20 465.20 KMA752 (Lomas)

460.25 465.25 KMA752 (Lomas)

460.275 465.275 KMA752 (Lomas)

460.325 465.325 KMA752 (Lomas)

460.425 465.425 KMA752 (Laguna Bch)

460.475 465.475 KMA752 (Laguna Bch)

460.50 465.50 KMA752 (Laguna Bch)

Transmitter Locations: KMA752 Laguna Bch, Lomas, Olldo, Orange, Santiago Peak, Westminster

KMM85 Orange

KMG294 Santiago Peak

KMG780 Buena Park

KMG796 Santa Ana

KMR35 Orange

(KPBB74 is a portable base on all channels)

**ORANGE COUNTY FIRE DEPARTMENT**

**Bases: 45.16 (#alsos 46.06)**

Mobiles: 46.06 46.14 46.26 46.28

Repeaters: 154.31 (KMR83)

Point-to-point: 458.55 (KMQ7)

**Bases:**

Botero Peak KMG49 KEP001 San Juan Cap KMD444

Capistrano B KMK503 Santa Ana KJA906

Cypress KMD48 KLI310

El Toro KMD40 (Intercity)

KMD549

Emerald Bay KMB54 Orange, Santiago Peak KUM277

Lagoa Bch #KLY949 Silverado KMD660

Laguna Hills KAA907 5 Laguna KJA435

Los Alamitos KAA907

Midway City KMD52 Sunset Beach KMD555

Mission Viejo KDU529 Trabuco Canyon KMD587

Modjeska KMD46 Tustin KMD562

Olive KMD45 Villa Park KAZ437

Orange #KMG880 Portable base KJJ311

**ORANGE COUNTY EMERGENCY STATIONS**

Newport Bch KLU725 45.92

Orange KIZ620 155.40 (County Hospital) KMK358 46.64 (Forestry Conservancy)

**ORANGE COUNTY LOCAL GOVERNMENT NETWORKS**

45.40 KJF314 KL1293

153.92 & 158.94 KAQ954 KCY558 KMK457

**COUNTY AGENCIES: RIVERSIDE COUNTY**

Riverside County Sheriff

Bases: Mobile Calls/Use

— 39.06 Walkie-Talkies

— 42.18 To CHP bases on 42.34

— 42.34 To CHP bases on 42.34

45.29 — KMM85 KMC46 (Intercity)

155.88 158.85 KMA758-80 KMA583 (Dispatchers)

159.07 — KMH970-1 KMY978 (Repeaters)

Transmitter locations:

KMA583 Indio

KMB78 Banning, Mt David, Whitewater

KMB79 Blythe

KMA880 Box Springs Mtn, Riverside

KMC56 Riverside

KMK790 Blythe
SOUTHERN CALIFORNIA

KMH791  Indio
KMQ89  Desert Center
KML46  Indio
KMV53  portable base

RIVERSIDE COUNTY FIRE DEPARTMENT

Mobile units: 154.28 154.445
Bases:
Banima  KDTZ37  154.28  154.445
Beaumont  KDTZ38  154.28  154.445
Indio  KLR83  154.28
Riverside  KEO271  154.28  154.445

RIVERSIDE COUNTY LOCAL GOVERNMENT NETWORKS

154.10 & 156.00  KGJ892-3 KMJ689

COUNTRY AGENCIES: SAN BERNARDINO COUNTY

San Bernardino County Sheriff
Base Mobile  County Sheriff
154.74  154.74  KMA795
155.43  KMC979  (Intercom)
155.55  —
155.91  —
155.97  155.97  KAZ309 KGH869 KGV219 KMA793 KMA795
158.89  KMB900 KMD829 KMH821-2
159.21 — KMC79 KMM616
456.25 — KMT57 (Point-to-point)
456.28 — KMT56 (Repeater)

Bases:
Barstow  KMT56  San Bernardino  KMA795
Big Bear Lk  KG589  KMM616
Fontana  KAZ309  KMC979
Needles  KMA793  KMT57
Ontario  KMD329  29 Palms  KMX949
Ramona Pk  KMH621  Victorville  KMX989
Yucca Valley  KG1219  Yuccaipa  KMH622

SAN BERNARDINO COUNTY FIRE DEPARTMENT

Mobile units: 154.07 154.19 154.28

154.07 Net  Barstow  KJZ659
Hesperia  KBO554  Big Bear Lk  KJW584
Joshua Tree  KON514  Bloomington  KKM869
Lucerne Valley  KB177  Chino  KMX842
Palmdale  KBQ239  Fontana  KMF634
Victorville  KCX403  Loma Linda  KJZ973
Yucca Valley  KLD789  Muscoy  KME271
San Bernardino  KMW885  ++also on 154.28

SAN BERNARDINO COUNTY LOCAL GOVERNMENT NETWORKS

Flood Control
Box Springs Mtn  KKN28  170.225
Bases & Mobiles  31.58  151.104  151.745
Repeater  456.05
San Bernardino  KKN27/9  171.975
Forestry Conservation nets

SAN BERNARDINO COUNTY LOCAL GOVT NETWORKS

27.275  KJ378 KLM651
153.705 & 155.775  KEE60 KJ510 KJ700 KQK59
153.765 & 155.115  KCO44 K-DH1 KJU633 KQ845 KQ850
KTQ74-5

COUNTRY AGENCIES: SAN DIEGO COUNTY

San Diego County Sheriff
Base Mobile  Cops
—  39.18  To Blythe PD base
45.70  45.70 45.78  KG4077  KMF312 KMQ519-21
45.90  KG737  KMF212
45.94  45.94  KMF312
158.45 — KFR33 KLA61 KRO97 (Unif. Po.)

Bases:
Descanso  KG737
Lyons Peak  KJ3521
Monument Peak  KJ3520
Mt Palomar  KJ519
San Diego  KMF312 KFR33 KLA61 KRO97

SAN DIEGO COUNTY FIRE DEPARTMENT

Bases: 154.250 154.235 154.28 154.325 154.385
Mobiles: 154.235

Stations:
Descanso  KG737
La Costa  KGB755
Dutiful KQ901 Palomar  KQ903
**     = Only operates 46.46

SAN DIEGO COUNTY MISC. EMERGENCY NETWORKS

CD network — 39.08
Emerg. Unit — KJ3550 Santee 155.325
DA — mobiles only KD2618 39.38
Local Government Networks
27.255  KJZ328 KQM962
153.875 & 154.055
153.995 KDLO98
158.32 & 159.94 KD5301 KD5305 KFM381 KJL374-6
KJ495

COUNTRY AGENCIES: VENTURA COUNTY

VENTURA COUNTY SHERIFF

Base Mobile  Cops
155.43 — KMB74 (Intercom)
158.27 —
159.21 159.21  KMA750 KME545 KMF707 KMG405 KMH963
458.55 — KDD25 KMQ49 (Point-to-point)

Stations:
Frazier Pk  KEM545 Ventura  KMB74
Meiners Pk  KMF707
Santa Paula  KMH623 KC405
Simi  KDD25 portable base  KMA930

VENTURA COUNTY FIRE DEPARTMENT

Mobile & Bases: 154.01 (+also 154.37

Canarillo  KLI239 Santa Paula  ++4 KMB552
Malibu  Simi
Newbury Pk  KCP583

VENTURA COUNTY LOCAL GOVERNMENT NET

158.745  KVX41

Astronomy

Continued from page 50

by radar. Studies have indicated that the surface of Mercury is rough and crater-marked, like the moon, while radar reflections from Venus point to a surface covered with silicon-composition rocks.

One of the most important determinations made possible by solar-system radar was a more precise figure for the mean distance from the earth to the sun. Many important calculations depend on both this mileage, including the navigation of both manned and unmanned space vehicles. Radar measurements have proven that the earth-sun distance is about 92,944,000 miles. Before, astronomers figured that it was close to 93-million miles but were uncertain about the exact figure.

The scientific study of the heavens that began with Galileo’s crude telescope in the seventeenth century is now undergoing tremendous upheavals and enrichment.

Science & Electronics
from the metal box with extra locking nuts. The circuit board is mounted in the same way.

When all holes have been drilled over the outer surface of the minibox with wood grained pressure-sensitive adhesive vinyl (Contact or equiv.) to make an attractive-looking instrument. A word of caution: when tightening mounting screws be sure to hold the heads of the screws rigid with a screwdriver and tighten mountings by using a socket wrench on the nuts; otherwise, the vinyl sheeting will be pulled and stretched by the bolt heads. Trim vinyl around the holes with a razor blade before mounting components.

To make your project really professional-looking, letter the controls with press-on letters (Datak or equiv.). Spray lettering with several coats of clear acrylic for protection.

**Electrical Assembly.** Most of the electronic circuit parts are mounted on the circuit board. We suggest you use G or P pattern perfboard as the hole spacing matches the pin spacing of the ICs we used. The components are mounted flat on the board and push-in clips and/or eyelets are used to facilitate mounting and connecting. The leads of the ICs are pushed through the perfboard and bent outward against the board. This holds the IC in place and provides a tab to which leads are soldered. Inter-component wiring is made with #26 bare copper wire. Where wires cross over they are insulated with plastic tubing.

Wire the circuit card in accord with the schematic. Be sure electrolytic capacitors and diodes are properly polarized before soldering to them. Also make certain that the ICs are correctly positioned before you solder them in.

**Alternate IC Mounting.** You may want to use a socket for the IC. As a matter of fact, the investment of less than a dollar for a socket is well worth it. You solder to the socket, rather than to the IC, thus reducing the possibility of damaging the IC with excess heating. You also have the advantage of being able to plug in the IC for proper orientation and or replacement should this be necessary.

Use an alligator clip temporarily clipped to a lead when soldering Q1 and the diodes.

If you elect to solder in the ICs, you should use the heatsink on each of their leads, too.

The circuit card is mounted on the left side of the indicator housing with four 4-40 bolts and nuts so that the card is supported away from the metal of the housing, as mentioned earlier. Inter-connect the various components not part of the card except for the meter.

**Meter Modification.** Any 0.1 mA meter having a coil resistance of under 100 ohms can be used for M1; the one we used measures approximately 14 ohms. However, the meter scale will have to be changed from 0.1 mA calibrations to 0-30 mph. See the Sept./Oct. 69 ELEMENTARY ELECTRONICS "Meter Scales You Can Count On," for details on how to do this most effectively. You can just turn it over, spray it with flat white, and then follow the steps outlined in referenced article. To mark the scale, use press-on letters.

**Checking It Out.** Plug in the remote pulse generator, turn on the AC power, and give the rotor a spin. If all has gone well you should get an indication on the meter. Check both ranges (X1 and X3).

If nothing happens, start out by checking all wiring for possible glitches, cold soldered joints, shorts between pins of ICs and transistor Q1, etc. See if +3.6 V is present on pin 11 of both ICs. Also check to see if the exciter lamp in the pulse generator is lit. Doublecheck the polarity of all electrolytics and diodes and also check to be sure the ICs are oriented correctly.

**Calibration.** When you get an indication on the meter by rotating the wind cups, the meter reading in the X1 position should be three times the reading in the X3 position for a given speed of the rotor. While maintaining rotor speed by hand, switch back and forth to determine if meter readings are correct.

Tracking between these two ranges is dependent on the capacitances of C7 and C8. The capacitance of C7 should be exactly half that of C8. Since capacitors can vary as much as ±20% or more from the nominal value indicated on them and still are considered commercially acceptable, you should check their capacitance on a bridge if at all possible. If not, you can trim them by adding small capacitors until the desired meter range is reached.

To do this turn the rotor by hand to produce a reading of 15 mph in the X1 range. If the reading drops below 5 mph in the X3 range
range add capacitance in small increments until it reads 5 mph. If it indicates more than 5 mph add capacitance to C8. Add capacitance in steps of 0.01 µF or 0.02 µF to align the two ranges.

**Adjusting Meter Reading.** Once the proper range tracking has been established, probably the easiest way to complete the calibration is to do it in your car where you have a reasonably accurate speedometer to serve as a calibration standard. Unless you happen to have a car with a 6-V battery (very rare these days—most use 12-V batteries) you will need 6 VDC, either from 4-D cells in series, or a 6-V lantern battery. Disconnect one side of T1 and bring out a pair of leads, one of which is connected to the indicator's ground and the other to the collector of Q1. The ground lead is connected to the negative and the collector lead to the positive of the 6-VDC source.

Also remove the leads connected to X and X1 on the secondary of T1. Connect a pair of leads between pins A and B of J1 and the external battery. This provides current to light exciter lamp when operating Windy from an external DC power source while calibrating in a car ride. Once the calibration has been completed remember to restore this modified wiring to its original condition as well as the modification to the battery wiring.

You'll need a friend, either to drive the car while you make adjustments or to make the adjustments for you while you drive. Calibration should be done on a calm, windless day if at all possible. Should there be a light breeze you'll have to average the calibration by checking readings obtained by driving in both directions.

With the car traveling at 30 mph (according to its speedometer) and Windy's indicator set on X1 range, adjust R6 until the meter reads 30 mph. This is the only calibration necessary as you have already corrected the ranging, as previously mentioned. (Of course you've temporarily mounted the wind cup pulse generator outside the car so as to be in the wind's stream.)

**Installation.** Now that Windy has been built and calibrated, where is the best location for the remote wind cup pulse generator to give a true indication of wind speed?

The pulse generator unit should be mounted 5 to 10 ft. above the building on which it's being used. It should not be mounted in the lee of a taller building and the arms of the rotor should remain level as they rotate.

We recommend that easily-available TV antenna mounting hardware (e.g., mast clamps, mast mounting base, etc.) be used to mount the remote unit above the roof of the building.

The lubrication recommended won't be affected by temperatures below 0 F.

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**SemiPro**

*Continued from page 58*

the SemiPro from 143.75 to 148.25 MHz.

A final adjustment before disconnecting the signal generators; set the generator for a 145 MHz output signal and the SemiPro dial to the 145 MHz calibration. Adjust L1 for maximum signal output on the BCB.

**Operating SemiPro.** Since propagation of 2-Meter signals is line of sight and doesn't follow the curvature of the earth, an outdoor antenna erected as high as possible will be required for best reception.

At the personal preference of the ham operator, his signals may be either horizontally or vertically polarized. Suitable antennas are listed for both types in most parts suppliers' catalogs. A ground-plane antenna is used for vertical polarization and a halo or beam antenna for horizontal polarization. You may find a conventional TV antenna suitable for stronger signals. Always use a coax cable matched to the impedance of the antenna as a lead-in from the antenna to the SemiPro.

A last word, a tip on tuning the SemiPro: tune the dial slowly, else you can easily pass over signals due to the high selectivity. Once you have a signal try slight rocking of the BCB dial as a bandspread for best results. Another tip—the 2-Meter band is generally more active during evening hours and on weekends, since most 2-Meter enthusiasts can't take time from their work to participate in the pleasure of hamming on the 2-Meter band during working hours. Once the boss's yoke is lifted the boys really hop to it for the pleasure of keeping the rig going strong making QSLs whenever they raise signals. That's when you can enjoy hearing all of the action with your SemiPro.
HAM TRAFFIC
Continued from page 67

then killed part of it—even though it was definitely showing good results. This recent FCC decision has been nothing but a slap in the face of the serious, hard-working hams who were sincerely trying to upgrade their abilities. It makes the Federal government something of a turncoat and leaves a lot of hams wondering just which way the wind will blow next.

As other evidence of a lack of firm, meaningful direction at the Candy Company, take the extension of the Novice license term to two years. This didn’t seem too bright to me when it was done, but then the felony was compounded when the Candy Company began allowing previously-licensed hams to obtain Novice licenses. This seems pretty silly, and certainly is diametrically opposed to the incentive regulations which are intended to encourage hams to improve their abilities.

Look at it this way: one regulation encourages hams to upgrade themselves by taking a harder exam; the other encourages the lazy ham to drop out for one year, then get back on the air with a Novice ticket. With it he can operate for two years, then drop out for a year, then get another Novice ticket for two years... and learn nothing in the process. Does this make sense? Is this likely to inspire the gray beards at an international frequency conference?

Where Are Incentives? And what about the proposal for opening up the entire 2-Meter band to Technicians? With more and more of the serious ham work being done on the higher frequencies, is this any way to demonstrate that the U.S. is encouraging hams to upgrade themselves? It looks more like giving a reward to those who are content to get a lower-class license and stick with it, doing nothing tangible to improve their knowledge or skills. How will this move look at an international frequency conference? The same can be said for the movement to give part of the 10-Meter band to Technicians.

Another big gap in the regulations that has rankled many hams is the fact that technical standards for ham operations are so vague in the FCC regs. All sorts of laxity in equipment operation must be tolerated merely because Uncle has said so little about just what is considered proper from a technical standpoint. Some of us hoped, after incentive licensing was written into the regs, that additional regulations would be forthcoming, setting more precise technical guidelines for equipment operation. This would be a natural development to match the increasing technical knowledge that many operators acquired to obtain a higher-class license.

Hams Aren’t Alone. This poor job the Feds have been doing of minding the store isn’t limited to hams, either. The commercial boys are constantly tugging and pulling, trying to get Uncle to rearrange some of the TV and government frequencies to allow more growth room for commercial channels, which are bursting at the seams.

When the Candy Company couldn’t figure out the answers, they spent some of our tax money to hire the Stanford Research Institute to study the situation. And you know what? When the Stanford crew issued their report, they blamed the FCC for “inadequate frequency management”! They said proper use of the available frequency spectrum might relieve most of the commercial congestion problems.

We do have a reward, though... in typical Washington bureaucratic style. There’s now talk of raising our license fees! They’re always thinking of us down on the Potomac, aren’t they?

Just as with the many other taxes which the Feds keep piling on us, these radio operating taxes wouldn’t be so hard to take if we got a better shake for our money. Which brings me to the whole point of this rambling piece of typewriter fodder.

We Need A Plan. No human activity can last long, or achieve much, unless it follows a plan. And that’s what ham radio seems to be almost without just now.

A couple of years ago, it looked like the principle of incentive licensing was going to give us a flag which serious, constructive hams could rally around. It still is to some extent. But its effect appears to be watered down by more recent actions and musings by the Candy Company, which is the outfit that gave birth to the incentive idea in the first place!

Apparently, the real incentive to prove our worth must originate in the ranks of hams themselves.

Somewhere, somehow, there must come a statement of goals for ham radio and a course to follow to achieve them.

APRIL/MAY 1970
monitor, and, of course, the reverb unit. Located on the front panel is a stereo beacon lamp and a lamp for indicating when interstation noise muting is on (because noise muting also mutes very weak stations that usually are unsuitable for good stereo reception).

The front panel contains variable controls and switches for bass and treble, balance, volume, input selection, speaker selector, mode, preset tuned frequencies, AUTO-SCAN, manual tuning, loudness contour, high and low filters, and FM muting. On the rear arc two switched AC outlets and an AM ferrite rod antenna as well as external AM antenna terminals.

Performance. Rather than displaying the usual performance curves that require the reader to calculate actual performance data, we'll state the facts as we measured them. You'll not have to apply a straight edge to a curve to find performance characteristics.

The IHF FM sensitivity checks out at 0.5 to 1.7 µV, depending on frequency, which is excellent. Frequency response is essentially ruler-flat from 20 Hz to 15 kHz at 0.35% total harmonic distortion (THD) through the power amplifiers. That's real performance!

At the clipping level the power amplifier delivered (per channel) 62W rms into 8 ohms, 41W rms into 16 ohms, and 62W rms into 4 ohms. THD at full power is no greater than 0.18%, which is excellent.

Frequency response at full power output (not at IHF one watt test level) measured -2 db, +0 db, from 20 Hz to 20 kHz.

Through individual effort, and through our many clubs and associations, we must make it clear that we want a constructive plan for the future development of ham radio so that hamming can continue to be a fruitful technical training ground, a public service facility, and a source of world-wide unity and goodwill. If this isn't done, we will see ham radio deteriorate into an idle playing that has little value to anyone. We've seen that happen in just a few years to another radio service which once seemed to have great promise. We don't want that to happen to ham radio, too!

Fisher Model 500-TX

Continued from page 66

Again, at the 1-watt test level response is ruler flat from 10 Hz to 20 kHz. Tone-control range provides 23 dB boost and cut at 50 Hz and 22 dB boost and cut at 10 kHz.

Phono input hum and noise level is 60 dB down (practically dead quiet). AM receiver performance is average, not bad but not outstanding either.

Summing Up. The Fisher 500TX is a feature-packed receiver having outstanding FM sensitivity and superb tone reproduction quality. Though the price of $449.95, plus an optional walnut finished cabinet at $22.95, may be too steep for your budget at present, make a trip to your local Fisher dealer to see and hear the 500TX—you'll really want one after that.

For additional information, write Fisher Radio Corp., Dept. JS, 11-40 45th Rd., Long Island City, N.Y. 11101.
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The demand for licensed men is enormous. Ten years ago there were about 100,000 licensed communications stations, including those for police and fire departments, airlines, the merchant marine, pipelines, telephone companies, railroads, trucking firms, delivery services, and so on.

Today there are over a million such stations on the air, and this number is growing constantly. And according to Federal law, no one is permitted to operate or service such equipment without a Commercial FCC License or without being under the direct supervision of a licensed operator.

This has resulted in a gold mine of new business for licensed service technicians. A typical mobile radio service contract pays an average of about $100 a month. It's possible for one trained technician to maintain eight to ten such mobile systems. Some men cover as many as twenty systems, each with perhaps a dozen units.

**Coming Impact of UHF**

This demand for licensed operators and service technicians will be boosted again in the next 5 years by the mushrooming of UHF television. To the 300 or so VHF television stations now in operation, several times that many UHF stations may be added by the licensing of UHF channels and the sale of 10 million all-channel sets per year.

**Opportunities in Plants**

And there are other exciting opportunities in aerospace industries, electronics manufacturers, telephone companies, and plants operated by electronic automation. Inside industrial plants like these, it's the licensed technician who is always considered first for promotion and in-plant training programs. The reason is simple. Passing the Federal government's FCC exam and getting your license is widely accepted proof that you know the fundamentals of electronics.

So why doesn't everybody who "sinks" with no electronics training get an FCC License and start cleaning up?

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CIE courses are so effective that better than 9 out of every 10 CIE-trained graduates who take the exam pass it. That's why we can afford to back our courses with the ironclad Warranty shown on the facing page: you get your FCC License or your money back.

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